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IN THIS ISSUE

TECHNICAL QUARTERLY
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DATA ON INTERFERENCE FILMS

Fish-Schurman Corporation have published a technical bulletin describing their FS Multi-layer, High-Efficiency type Interference Films useful as beam-splitters in optical systems. Write them at 70 Portman Road, New Rochelle, N. Y. and ask for Bulletin MI-318 R. It is free for the asking.

The interference filters are produced by vacuum deposition of materials on optical glass surfaces and are the most efficient light dividers known. They are used in color motion picture printing, in color television projection receivers, in flying spot television scanners, gun sights, range finders, interferometers, and many other visual and electronic devices including periscopes for viewing radarscopes and photographing them simultaneously.

KODAK TRI-X FILM PACKAGED FOR MINOX CAMERAS

Kodak Tri-X Film packaged in special magazines to fit Minox cameras is being offered by Kling Photo Corporation, 235 Fourth Avenue, New York 3, New York, the U. S. distributors for Minox products.

The Tri-X film in Minox magazines, along with an exposure guide, is being packaged two cartridges of 36 exposures each—$2.50 per box. Camera owners who have been reloading the special Minox camera magazines with 35mm bulk film will be interested in this new service.

LIBRARY OF CONGRESS ISSUES LIST OF AMERICAN PHOTOGRAPHS

The Library of Congress has published a revised and enlarged edition of its *Pictorial Americana*—a list of photographic negatives on American life and history, selected from the Library's collections, from which prints may be obtained.

Nearly 4,000 negatives, representing a broad range of American pictorial history, are listed. They represent only a fragment of the collections in the Library's Prints and Photographs Division; but the catalog includes only materials for which negatives have already been made in response to orders for reproduction. Prints may be ordered from this list without the cost of making negatives. As the Library receives requests for additional negatives of other original materials, the list will grow more representative of the total collections.

Compiled by Milton Kaplan of the Prints and Photographs Division and edited by Charles G. LaHood, Jr., of the Photoduplication Service, the list may be purchased from the Photoduplication Service, Library of Congress, at 25 cents a copy.

Titles of the negatives are listed under three broad groupings in the catalog—"History (through 1899)," "Views," and "General Subjects." The first section, beginning with Christopher Columbus and ending with the Spanish-American War, is chronologically arranged and includes engravings, lithographs, and drawings as well as photographs; a large portion is devoted to the Civil War. "Views" include buildings and historic landmarks, arranged by State; among the District of Columbia entries are early views of the Capitol and August Koellner's outstanding lithograph of the White House. The general subjects range from expositions, farming, medicine, and transportation to Presidents and presidential campaigns; the famous Brady picture of Lincoln that appears on the five-dollar bill and the Wright brothers' photograph of their first successful flight are among them.

INTERNATIONAL STANDARDS

World Standards for Photography were brought one step closer to reality by an international meeting in Stockholm June 6 to 10, 1955 for which the American Standards Association served as Secretariat. Fourteen resolutions were adopted. Some dealt with procedural matters but others ordered the circulation of "draft ISO proposals" for 13 projects based on existing American Standards and 1 project based on a British proposal. Subjects involved were residual hypo tests, roll-film dimensions, camera window location, 6 processing chemical specifications, shutter time and lens aperture markings, stability tests for photographic images, and identification of color films.

Series II, Vol. 2, No. 3 ☆ PHOTOGRAPHIC SCIENCE AND TECHNIQUE ☆ AUGUST 1955

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PHOTOGRAPHIC SCIENCE AND TECHNIQUE is dedicated to the publication of scientific and technical papers dealing with the theory and practice of photography. Its aim is to encourage the publication of authoritative articles describing original research, techniques, and the engineering aspects of new equipment in all fields of photography. It is intended to interest and inform the advanced amateurs, the professionals, the technologists, and the scientists who study or apply photographic processes.

Established in 1950, Photographic Science and Technique is prepared under the editorial management and control of the Technical Division of the Society. The first four volumes were issued as Section B of the PSA Journal and numbered 16B to 19B inclusively. As a separate publication, Series II, Volume 1, Number 1 started in the first quarter of 1954.

Members of the Photographic Society are entitled to receive both the monthly PSA Journal and this quarterly technical publication. Non-member subscriptions are available only to libraries, schools, and Government units at $5.00 a year ($9.00 for two years) for both publications together. Separate subscriptions are not available. Single copies, including back issues when available, at Society Headquarters in Philadelphia, $1.00 a copy. No extra charge for overseas mailing.

Address manuscripts and communications to the Editor.

The Associate Editors are available for advice and assistance in the preparation of manuscripts. Unacceptable manuscripts will be returned if requested. Authors will be sent galley proofs for correction. Reprints may be ordered by the authors prior to publication.

SILVER ANNIVERSARY OF PHOTOFLASH LAMPS

E. J. Hile*

A NEW ERA in photography began on August 1, 1930, when General Electric introduced photoflash lamps in the United States. The old cumbersome and sometimes dangerous system of producing light for flash photography employed flash powder ignited on metal trays. The use of flash powder involved smoke, odor, noise, danger of fire, and difficulty in controlling the amount of light accurately.

The relatively safe, efficient and easily operated photoflash lamps soon replaced the earlier method. There was no muss, no fuss, and the used bulbs were readily disposable. Flash bulbs so greatly increased the convenience of flash photography that they created a large new market among both professional and amateur photographers.

August 1, 1955 marks the 25th anniversary of the introduction of the photoflash lamp in this country. General Electric purchased the American patent rights of the inventor† of photoflash lamps, Johannes Ostermeier, of Althegnenberg, Germany. At Nela Park, G. E.'s Lamp Division headquarters, in Cleveland, specialists developed the lamps further. These first photoflash bulbs, of the same size as today's 150-watt household lamps, contained oxygen gas and a loose filling of crumpled thin aluminum foil. When the lamp was connected to a source of electricity a small filament in the lamp became heated. This caused sparks to fly from a zirconium powder "primer" coating on the filament and ignite the foil. The result was a flash of light of high intensity and short duration.

The desirability of a glass-enclosed flash lamp for photography was pointed out as early as 1898. However, no such lamp was produced commercially, so far as is known, until 1930, when General Electric introduced the foil-filled lamp.

The sheets of foil were so thin they could be ignited readily, and they burned with a short flash of high intensity. The light output could be controlled within reasonable limits by the amount of foil inserted, and the duration of the flash by various combinations of foil thickness.

These lamps were used initially for what is called "open shutter" photography, in which the camera shutter is first opened, the light flashed, and then the shutter closed. The light produced so predominated over the casual illumination existing that only action occurring during the short peak of the flash illumination would show on the finished picture.

Shortly after 1930 flash lamps also began to be used in synchronization with camera shutters for the taking of action shots of such activities as sports events. The use of the shutter was necessary whenever the duration of the flash produced by the lamp itself was not short enough to stop the action or whenever the camera was hand-held. By using a synchronizer, the shutter could be opened for the requisite short time during the peak of the lamp's illumination.

Because the peak produced by the leaf foil lamp was quite short, accurate synchronization with the camera shutter was required. Thus it became desirable to develop a longer-burning lamp, which would allow greater leeway for errors of synchronization. In 1938 General Electric broadened its flashbulb line by introducing a lamp filled with aluminum wire, and having a flash of long duration. Also introduced was a lamp filled with heat-treated foil, thicker than sheets used earlier, having a flash of intermediate duration.

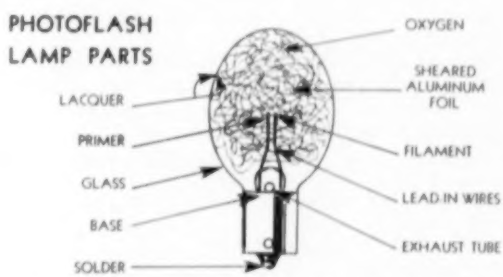

Fig. 1. Construction details of the No. 5 "Midget" flash lamp. General Electric expects this most popular flash lamp today to be superseded by the super-midget M-2 flash lamp within a few years time.

The demand for broad-peak lamps was greater than G.E. could fill, largely because of the cumbersome and expensive drawing process required to produce the aluminum wire. Accordingly, the company sought and found a new method by which to produce lamps having the desired long-burning characteristic. This new method involved the production of shredded foil. Much thicker aluminum foil than was used in the sheet foil lamps was cut into thin eight-inch-long strips or ribbons, several hundred of which were sucked into each lamp by vacuum. The number of strips depended on the amount of light desired. Fluffing of the shredded foil within the bulb was effected by a jet of air.

The lamps filled with shredded foil were marketed in 1940, replacing the wire-filled types. Shredded foil also was found to be a satisfactory substitute for the leaf foil used in General Electric's lamps of intermediate and short flash duration. Hence by 1942 leaf foil was dis-

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* News Bureau, General Electric Company, Nela Park, Cleveland 12, Ohio. Received 10 May, 1955.

† The Ostermeier patent (U. S. 1,776,637 dated September 23, 1930, reissue 18,678 dated December 6, 1932) acknowledges the prior art in these words: "Flash lamps are already known in which an oxidizable metal in the form of wire or ribbon or a flash mixture is lodged in a gas-tight transparent bulb which contains a filling of oxygen, of an oxygen-gas mixture, or of a gas that gives off oxygen, such as an oxide of nitrogen as N_2O, at a pressure less than atmospheric. From these known flash lamps the lamp according to the invention differs by the fact that foils of oxidizable substances, more particularly of metals and metal alloys, are used as a light producer which foils are so arranged in the bulb as to be in the range of the igniter." (Ed.)

Fig. 2. Sizes of flash lamps in most general use today. From left to right are the M2 "peanut" bulb, the PH/8, the PH/SM "Speed Midget" lamp, the PH5 "Synchro-Press" lamp in its clear envelope, the PH/5B blue lacquered version of the PH/5, the PH/6 Focal Plane type "Synchro-Press" lamp, the PH/6B blue lamp, and the PH/11 in both its clear and blue dyed forms.

continued, operating characteristics of the lamps being changed to suit the demands of the market by varying foil thickness, width of the cut, and number of shreds per lamp. The course of G.E. development of photoflash lamps, as documented by U. S. patents issued, is shown in Table one.

Table I

SIGNIFICANT U. S. PATENTS ON G. E. FLASH LAMPS

Number	Inventor	Issue Date	Subject
Reissue 18,678 (Orig. 1,776,637, 9/23/30) (Orig. German, 2/28/29)	Ostermeier	12/6/32	Original No. 20 leaf-foil filled flash lamp. Ten claims
2,280,598	Meridith	4/21/42	Primer chemical composition
2,285,125	Pipkin	6/2/42	Primer chemical composition
2,291,983	Pipkin	8/4/42	SM-type flashbulb
2,306,563	Pipkin	12/29/42	Elipsoidal flashbulb shape
2,334,155	Oram	11/9/43	Focal plane type flashbulbs
2,351,290	Rippl, et al.	6/13/44	Shredded foil flashlamps
2,465,068	Dana	3/22/49	Blue filter for flashlamps
The three important manufacturing patents covering shredded foil for flashlamps are:			
2,297,368	Rippl, et al.	9/29/42	Strip or ribbon making method and apparatus
2,331,230	Rippl, et al.	10/5/43	Strip or ribbon making method and apparatus
2,247,046	Geiger, et al.	4/18/44	Method and apparatus for loading flashlamps with shredded foil

Applications are pending on the M2 flashbulb, a more sensitive primer composition, and a thinner filament, all introduced by G. E. in 1953.

The Midget Flashbulb

Introduction of flashbulbs with shredded foil was preceded in 1939 by General Electric's introduction of the "midget" flashbulb, considerably smaller than existing photoflash lamps, but delivering more light for its size than any other photographic lamp.

Unlike all other flashbulbs, which were equipped with the conventional medium screw base, the midget employed a bayonet-type base, which lent itself to rapid loading and unloading in reflector units. Because of its small size, it could be used with more compact flash equipment.

Originally used largely by press and professional photographers, the midget flashbulb, designated the No. 5, revolutionized the picture-taking habits of the nation because of its convenience, its high light output, and its low cost. It greatly stimulated both amateur and professional photography, both indoors and out.

Another important development of this period was the marketing in 1940 of General Electric flashtubes. These tubes produced tremendously brilliant flashes of light over time intervals ranging from 1/1000 to 1/1,000,000 second. The same tubes could be flashed repeatedly, some at frequencies of up to 10,000 flashes a second.

In 1953 G.E. made an important improvement in the flashability of its product. This improvement, making bulbs twice as easy to flash, was effected by using filament wire drawn to half the size of previous filaments, and a new primer considerably more sensitive to filament heat. This improvement was an important advantage to photographers operating flashbulbs from dry-cell flashlight batteries.

Steady reduction in the size of flashbulbs through the years was made possible by improvements in design and manufacturing skill. But it also was made desirable because photographic film manufacturers were able to make their products increasingly sensitive.

The M2 flashbulb was introduced as "the world's smallest, most useful, most convenient, least expensive, and safest" flashbulb yet made. Although scarcely as large as a peanut, it produces as excellent a photographic result with modern "fast" film as did the original flashbulb with film existing in 1930. The base is of the miniature type, but without either pins or screw threads. It is pushed straight into the socket, and needs no positioning or turning. Photographic equipment manufacturers have introduced a number of compact camera-flash units designed especially for use with M2 lamp.

Although the tiny bulb was intended largely for the amateur box-camera user, it also has been welcomed by advanced amateurs and professionals for use with their focusing-type cameras. It is expected soon to become the most popular of all flashbulbs, passing even the now-dominant No. 5 in use.

Fig. 3. Interior view of Bellevue, Ohio flash lamp manufacturing plant of General Electric Company. Lamp fabricating machines are shown on both sides of a conveyor belt that is bringing finished lamps to an inspector for spot checks from each box.

Table II

INDUSTRY PHOTOFLASH SHIPMENTS IN THE UNITED STATES (1930-1954)

Year	Unit Shipments (000's)
1930	303
1931	1 907
1932	2 000
1933	2 500
1934	2 971
1935	3 688
1936	4 655
1937	7 211
1938	9 380
1939	11 441
1940	14 769
1941	23 411
1942	42 288
1943	19 464
1944	33 531
1945	35 157
1946	43 049
1947	75 356
1948	140 578
1949	152 310
1950	226 538
1951	289 497
1952	335 458
1953	478 180
1954	447 656*
1955	515 000 (Estimated)
25 Year Total to August 1, 1955	2 700 000 000

* Use of flashbulbs continued to rise in 1954, the drop in shipments resulting from an inventory correction.

Fig. 4. Quality control in flash lamp manufacture at General Electric requires inspections after virtually each stage in manufacture. Here a factory worker checks the manner in which bases have been fastened to the bulbs.

Impact of Flashbulbs

Since General Electric introduced the first photoflash bulb in the United States on August 1, 1930, more than two billion flashbulbs have been produced in this country. Production has reached the rate of half a billion lamps a year, about 24 percent of all electric lamps of all types. Flash lamps produced in one year have a retail value of $65,000,000.

Flash photography is believed to be America's fastest growing hobby. Approximately 19 million of the 36 million cameras owned in the United States are equipped for flash picture taking, and virtually all new cameras now being made are equipped with internally synchronized shutters.

It is estimated that about 26 percent of all pictures taken are with flash, and experts see 45 percent as a realistic goal for the immediate future. In the near future flashbulb production is expected to reach the 700,000,000 rate annually.

In 1938 the annual production of flashlamps, used then mainly by press photographers and other professionals, was only nine million units. By 1942 the amateurs were in the flash-photography field to such an extent that production of flashbulbs soared to 42,000,000 annually. During World War II, G. E. cut back its production of lamps for the amateur market, directing all its bulbs to the armed services, press photographers and other professional users. Production dropped to a low of 19 million in 1943, and didn't regain pre-war levels until 1946.

Millions of box camera users began to take hundreds of millions of "candid" shots with and without flash. Thousands of camera clubs were formed. Only 75 million bulbs were produced in 1947, but by 1949 the figure was 152 million. Trying desperately to keep up with the demand, flashbulb manufacturers produced 289 million in 1951 and in 1953 the number soared to 478 million. The rising trend of flash lamp production in the United States is shown in Table two.

One of the most intriguing prospects to come out of the miniature flashbulb development is the automatic flash camera, which fires a half-dozen or so bulbs in succession, in much the same manner as a revolver fires its bullets. This trend toward repeating flash is likely to be a continuing development by manufacturers of photoflash equipment.

PAVELLE PREPARES EXHIBITION PRINTS

Pavelle Laboratories, Inc., 16 East 42nd Street, New York 17, N. Y., announce an Exhibition Print Department to serve commercial and industrial organizations and photographers.

This new department will prepare complete photographic exhibits, at $4.25 per 11 × 14" print, toned, mounted and matted, ready for display.

Business firms and individual photographers have long used this service which the Pavelle organization introduced some years ago. Photographic exhibits for leading museums, government agencies, publishers and noted photographers have been prepared by the Laboratories who now offer the service to individuals. Exhibitors in photographic salons will thus be able to prepare entries of paper print enlargements with the same ease and freedom from effort that the color transparency slide exhibitors have long been enjoying, thanks to the efforts of color film processing and mounting services.

INTELLIGENCE IN PERSPECTIVE

R. W. Richman*

In the world of technological activity, almost everyone is concerned with the more or less permanent preservation of certain data or information in its exact form. The term "permanent photographic record" often refers to Photostat† copies or microfilms of printed information. But cameras have many other intelligence uses, many of which have only recently come into use, although most of the procedures are basically quite simple. It is the purpose here, to inspire a greater familiarity with the camera record and appreciation of its usefulness. An example: A contractor, planning various construction projects, finds it inconvenient personally to obtain on-the-spot information frequently, because of time and distance from his office. Also he wants to avoid the expense of a number of engineer crews to run levels and cut-and-fill data. Instead, one engineer takes a series of carefully documented and positioned photographs, and then determines much of the data more readily, in the office, during rainy days or during the progress of other construction which normally would interfere with on-the-spot surveys.

The photographic perspective view produced by a camera is a source of far greater amounts of interesting information than the average person realizes. Each viewer receives a certain impression from a photograph, but doubtless fails to note other effects in the same photograph. The principal reason for this is the observers' difference in background and experience. The intelligence photograph (Figure one) may seem flat and lacking in contrast compared with pictorial or salon prints.

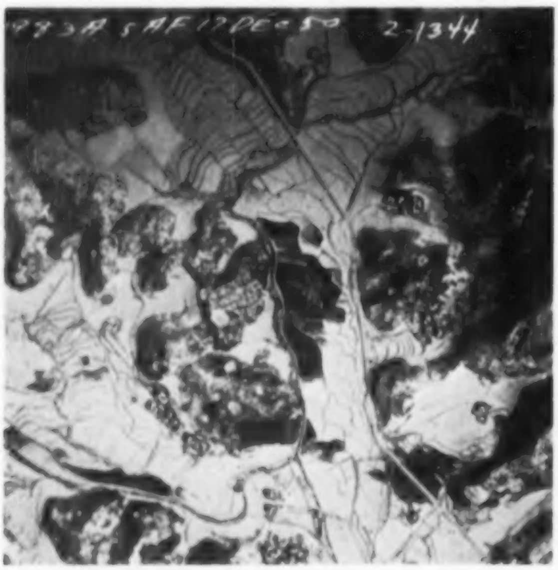


Fig. 1. Korean tapestry. The photographic interpreter must decide if it is timber or troops, revetments or rice fields, haystacks, huts, or hidden guns.

There are two important reasons for this. First, of course, is the fact that intelligence photography is often taken under rather adverse exposure conditions, sometimes while under enemy fire. Second, the intelligence photographic print is purposely developed rather flat, in order not to "burn out" the highlights nor to darken and obscure details in the shadows.

There are many kinds of photographic records and types of subject matter. The range of photographs extends from news photography, through aerial photography, and into specially set and staged photography, such as the finish of a race, or the record of atomic particles in a laboratory cloud-chamber.

The types of photographs mentioned thus far range from almost purely qualitative subjects to rather precise quantitative records. In Naval Photographic Intelligence work, interest lies in the middle range; in subjects (Figures two and three) covered by the term "geographic intelligence." This includes both the Cultural Geography, (that is, the various human activities and structures,) and Natural Geography, (which includes terrain, drainage, condition of landing beaches, etc.).

Successful photographic interpretation springs from knowing what to look for, and what to see. There is a great difference between looking at pictures, and studying photographs. Inspection of intelligence photography involves a definite search for items of specific importance; also there exists the need for sharp focus, and extreme resolution since the photographs are scanned for details.

Nor is the study of military photography like viewing pictorial exhibits; it is more serious business. Examine Figure four. It is a quiet, picturesque old German town; it almost seems to invite a leisurely sightseeing stroll. But if one were to stroll into the picture he would see such sights as the rows of military tank obstacles on the far bank of the river. If this were recent photography, it would be inspected very carefully, to locate and tabulate all evidence of military and strategic civilian activity thus confirming and adding to the existing intelligence records and map overlays of this area.

The photographs shown in Figures five and six contain various objects of common familiarity, by means of which the experienced photographic interpreter is able first to recognize and identify the subjects, then decide what activity is occurring, and finally to determine what use it serves, whether recreation, commercial enterprise, military activity, etc.

The foregoing examples show something of the activity of interpreting photographs; but to produce full intelligence reports, identification is not enough. The

* U. S. Naval Photographic Interpretation Center, U. S. Naval Receiving Station, Washington 25, D. C. Presented at the PSA National Convention in Chicago, Illinois, 6 October 1954. Received 28 March, 1955.

† Trademark of the Photostat Corporation, Rochester, New York, for their line of photographic copying materials and equipment.

Fig. 3. Geography of amphibious area. Assault route to airstrip is here dictated by reefs, vegetation, beach conditions and domination of cliffs.

Fig. 4. This quiet German town is not so peaceful to the military interpreter as it might appear to the uninitiated.

photographic facts relate to a specific intelligence objective or subject-area; and must be correlated with the previous file for that particular area. Intelligence results from an observation of pertinent facts in the photography, followed by recognition of meaningful relationships between these data; and final communication of the meaning in a report. Thus the industrial activities and amounts of production may be tabulated into an intelligence file of the potential military effectiveness of each city or area, whether in capacity to repair sea-going vessels, or to produce finished steel, or electrical power, or what-have-you.

Intelligence reports always include measurements of capacities, volumes, distances as well as qualitative data, much of which could not have been obtained by a person observing with his own eyes, because he could look at only a part of the scene at a time, and is physically incapable of observing very slow or very fast activities. The camera records these things admirably, and the photographic record later recreates phenomena to the observer at whatever motion picture speed or stationary period he may wish in order to study the subject matter.

And, as if this were not enough, cameras will do more. Since the photographic record is taken from one pinpoint position (the perspective center of the camera lens) it is thus a precise source of position, direction, and other dimensions, recorded beyond question, for reinspection and recheck. And the final marvel is that with two photographs, properly exposed from different camera locations, there results a precise three-dimen-

Fig. 2. Oblique aerial photograph of an Italian valley. Olive groves, acqueduct or railway bridge may provide the photographic interpreter with strategic information.

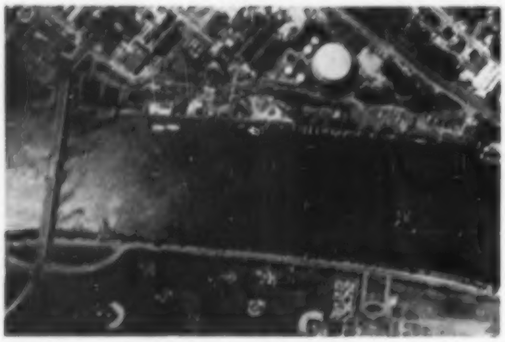


Fig. 5. Close-set playing fields near houseboats and a gas plant suggest a busy, expanding city.

sional record of all surfaces, and of the speed and course of moving objects. Thus, the position of a mountain top may be pinpointed on a map; the position of a foreign particle in the human body determined for the surgeon's benefit; and the aiming point for a guided missile directed from television scanners.

That there exist many such potential and actual techniques of photography, is common knowledge among military research and intelligence personnel. (It is interesting to note that these techniques can almost all be traced back to the analyses of one man, the 18th century mathematician, *Brook Taylor*, who published in 1715 a comprehensive treatise on linear perspective.)

During the first atom bomb tests at Bikini, aerial cameras were used to record the position of ships, the exact position and height of the bomb at instant of detonation, and other dimensions such as the size of the column of water, the speed of the shock wave, etc., with accuracy to a fraction of one percent.

The scale of an aerial photograph is inversely proportional to the distance of the camera from the ground (at the plumb point, or nadir, directly beneath the aircraft). This scale is expressed as a ratio of f/H, or focal length divided by flying height. From such a scale comparison (Figure seven) can be determined the true flying height of an aircraft or a rocket from which a photograph has been taken.

Because they are closer to the camera, tall objects or elevated terrain such as plateaus, are at a larger scale.

Fig. 7. From 20,000 feet, with a 30 centimeter lens, one mile records in a 3-inch space.

On a photograph, this effect may be noticed as a greater separation between the tops of two vertical objects as compared with their bases. The effect also makes tall objects (Figure eight) appear to lean away from the nadir position. Elevated terrain points must also be displaced in this radial manner, therefore use of a "radial plot" from two or more photographs will determine the true locations of elevated points, all at one common scale.

Instead of converting these scale differences of the photograph to a constant-scale or map presentation, one may take advantage of these perspective effects to determine heights of objects. Any light ray passing from the top of a vertical object to a known position on level ground will produce a right triangle. From the photographic information one can reconstruct the height of this object triangle.

Fig. 6. Potential sea power is in the steel mill and shipyard here shown at nearly full production.

Fig. 8. Objects here appear to lean away from nadir area at the lower edge of figure; different distances from camera produce this perspective effect.

For illustration, consider a light ray cast by the sun. It is marked on the ground by shadows. The length of the shadow is of course in direct relation to the height of the object. Furthermore, the length of the shadow is obtained directly from the photograph. Having determined the height of any object, an adjoining object with, for example a shadow half as long, will be half as high: $\frac{h}{s} = \frac{h_2}{s_2}$

The light ray from the camera lens to the top of a vertical object forms a right triangle at the ground (See Figure 9). The base of this triangle is projected to the photograph by the light rays passing through e and g. These points represent the images of the top of the object (elevated point) and base (ground point) respectively and the photographic distance between e and g is called the displacement (d) due to relief. Furthermore the light ray representing the nadir (N_1) or plumb point passes through the center of the photograph at P_1. (The center of the aerial photograph is available from the reference marks, or "fiducials" on the edges of the frame.) [e.g. note frame of figure 12] One thus can reconstruct the proportions of two triangles on the ground, and determine object height (h) from this relation.

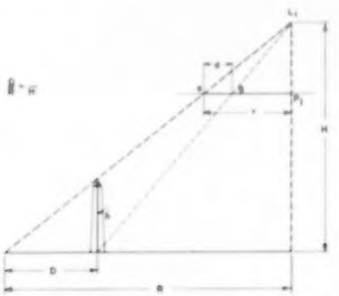


Fig. 9. **Proportional triangles provide object height if height of camera is known.**

$$\frac{h}{H} = \frac{D}{R} \quad \text{or} \quad \frac{h}{H} = \frac{d}{r}$$

(The flying height, H, may be obtained from scale analyses as mentioned previously or from altimeter records.)

One can determine heights of more difficult objects by use of stereo. A second photograph whose nadir (N_2) is at P_2, is inspected for the image of the previous nadir point (N_1) and this point marked on the photograph as the "transferred plumb point" (P_1, marked in parentheses). The distance between these two nadirs represents the distance between camera stations, and is called the airbase (B) or the photo-airbase (b). A first modification of the previous formula may be obtained from the fact that $R = B + D$, or $r = b + d$. Therefore, $\frac{h}{H} = \frac{d}{b+d}$, which is a correct stereo formula for objects in the path of the airplane. However, this relationship can be again modified for application to the general case in which the object appears to one side of the flight line rather than directly beneath the aircraft. The two photographs are held in a stereo-position while the distance between the two images of the top (e_1 and e_2 respectively) is measured. From this is subtracted the similarly measured distance between bases (images g_1g_2). The difference is the desired value. The distance d in this case, is replaced by just the x-component of d, as measured parallel to the flight line. Since this parallax component is always obtained from the difference of two measurements, it is called the differential parallax, with the mathematical symbol Δp. The *general* formula for elevation by stereo-parallax is obtained by substituting this symbol.

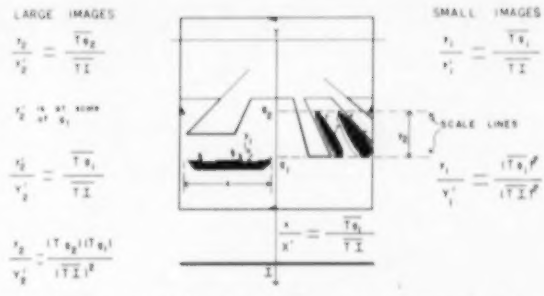
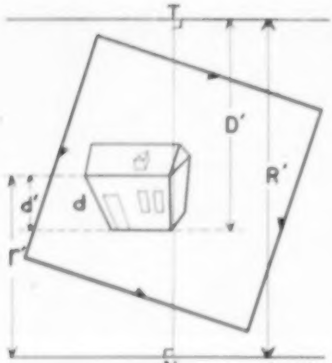


Fig. 11. **Un-primed y-values are foreshortened; y'- are true dimensions at image scale; Y'- are true at scale of Isocenter.**

$$\frac{h}{H} = \frac{\Delta p}{b + \Delta p}$$

Oblique photography may occur accidentally. Often it is intentional, because it is the most easily obtainable photography, gives a more familiar view than the "birds-

Fig. 10. **Objects in oblique views are variously distorted by perspective except at the "isocenter" which is here found near the dark tank in the foreground.**



$$\frac{h}{H} = \frac{d'}{r'}\,\frac{R'}{D'}$$

Fig. 12. Vertical object displacement *d*, is measured as *d'* parallel to the principal line.

eye" or vertical view, and gives a side view under roofs, of the sides of structures, and has numerous other advantages. If the photograph was taken from a high oblique angle, the horizon will appear in the view, which makes orientation and direction more readily available. If the photograph is a low oblique view, the location of the photograph horizon may be determined by graphic or mathematical procedures.

In oblique photography, the direction of the camera is indicated by a line, through P_1 (the center of the picture or "principal point") and perpendicular to the horizon. This is called the principal direction line or "principal line." It intersects the true horizon at the point *T*, called the principal vanishing point. Parallel objects such as streets, which are not however, parallel to the camera direction, would to an observer appear to vanish at some other vanishing point on the horizon at a specific angle, [say 30 degrees] from the camera direction. If the true [30°] angle is reconstructed over the imaged vanishing points on the photograph, then the vertex of that angle will be at the origin of true directions. This origin point is called the isocenter I ("eye"), and is defined as the center of tilt displacement. If the rays from the isocenter maintain true directions, then the isocenter must be distant from the photograph horizon by an amount equal to the distance of the lens from the photograph horizon line. Therefore the isocenter can also be located mathematically.

The isocenter has other properties. It is on the scale line which is equal to the scale of an equivalent vertical photograph, namely f/H, as described in a previous section. Also if the isocenter falls within the actual frame of the photograph (as it will in wide-angle photographs) then objects at that point will not be foreshortened. For example, a circular tank will be a true circle, whereas a similar tank near the horizon, viewed from a flat angle, would appear as a flat ellipse. (See Figure ten).

For the above reasons, the isocenter used as a reference for all distances and directions measured from an oblique view, permits the accurate determination of any dimensions. If, for desired items, their relative distances from the horizon are compared with the isocenter distance (TI) then the dimensions may be obtained from simple mathematical proportions. Illustrations of formulas used for oblique photography are included in Figures eleven and twelve. Note that for height formulas, the photographic horizon (*T*) and the nadir point (*N*) must be mathematically known.

From the facts of perspective foreshortening, formulas can be developed to compute the distance to the photographic horizon. This may be useful in low oblique views, as a means of obtaining the tilt and ultimately the isocenter. The simplest formula is based on the photographic measurement of two equal halves of a distance or object. For example, a bridge of eight equal spans appears in a photograph and the photographic measurement of each set of four is used to determine tilt.

This formula can be used when neither map distances nor symmetrical objects are identifiable in the photograph, if an adjoining oblique covers the same area. The adjoining oblique is used to identify bisected lines from which the horizon may be computed. Thus various means are available to analyze the tilt of oblique photography, and therefore to determine quantitative intelligence from whatever coverage may be available.

Color is a factor used metrically in intelligence also; items of manufacture are discovered by color difference, types of vegetation and resulting indication of type of soil and soil conditions, etc. From the panorama of photography, the intelligence officer reads histories, and lives and actions, and locations. These data, which are certain and beyond controversy, provide as nothing ever did before the full, related story of the facts.

This is intelligence in perspective.

PRINTER FOR COPYING FROM BOOKS

A Flat-Bed Contact Printer redesigned for photographic copying from books, bound volumes of magazines, and other records has been introduced by Hunter Photo Copyist, Inc., 595 Hunter Street, Syracuse, New York. The printer has a floating lid which allows a 1 1/2-inch clearance between lid and platen for the insertion of the material to be copied.

This equipment is also useful for copying originals on stiff board or heavy card stock that cannot be handled on a rotary printer. It can also be used for reflex or print-through copying from single sheet originals such as letters and invoices.

Used with a separate processing unit, this Model HT-1 unit makes copies in one minute with diffusion transfer copying materials such as Hunter's Hecookwik line. It can also be used with the conventional wet process materials. The lid has been made light in weight and the contact surface has been changed from a rubber pad, used on earlier models, to an aluminum sheet supported by leaf springs which insures good contact.

The platen is a one-half inch glass plate. Its front edge has been beveled at a downward angle of 45 degrees allowing light to penetrate right up to the binding of the volume being copied.

The light source for the printer is a single 15-watt GE green fluorescent tube, with a plastic ultraviolet ray filter to absorb very short light undesirable for reflex photocopying.

SELENIUM REAGENTS FOR RESIDUAL SILVER IN PRINTS AND FILMS

R. W. Henn and J. I. Crabtree*

ABSTRACT

Solutions of selenium compounds may be employed, instead of the usual dilute sulfide solution, to test for residual silver in prints and films and they have the advantage of better keeping properties. A diluted solution of a conventional selenium toner is suitable for this purpose.

THE YELLOW STAIN frequently encountered in the borders and highlights of aged prints is due to the decomposition of residual silver thiosulfate to silver sulfide. A visible stain can be produced by a very low concentration of silver salts, and it is important that the photographer be able to assure himself that these are absent in the freshly processed prints.

The simplest test for residual silver is to immerse the print in a sulfide solution or to spot it with such a reagent. This test has been used for over a century for "unfixed" silver and as a check of the capacity of the print fixing bath,[1] but was extended by Crabtree, Eaton, and Muehler[2] as a specific test for residual silver in the print. The Kodak ST-1 solution comprises a 2% solution of sodium sulfide which is diluted 1:9 immediately before use. The dilute solution was employed because more concentrated solutions frequently have sufficient color to stain even in the absence of silver, while dilution immediately before use was required because it was realized that the keeping properties of dilute sulfide solutions are poor.

In adapting this reagent for use in a "testing kit," Henn and Crabtree suggested[3] using the undiluted reagent, since the quality of sodium sulfide is better today, and even a 2% solution is not highly colored. However, it has now been found that such a solution is sufficiently alkaline (caustic) to react with the baryta coating of certain glossy papers and produce a pink stain ("baryta stain"), of sufficient density to invalidate the test. The photographer is then left with a rather poor choice; either having the chore of diluting the reagent immediately before use, or of restricting its use to non-glossy papers.

Selenium Reagents

The use of selenium reagents as an alternative test was then examined, since they offer stability advantages over sulfide. Successful tests were obtained with two variations: (1) potassium or sodium selenosulfate, and (2) a compounded selenium toner containing sodium selenite and hypo. The selenosulfate reagent is prepared by dissolving elemental selenium in a hot solution of sodium or potassium sulfite. In a typical preparation, 10 grams of elemental selenium (black) were mixed with 100 grams of potassium sulfite and a small amount of water to make a paste. Then a total volume of 250 cc. of hot (125 F) water was added, and the mixture stirred for 5 minutes. This was filtered with suction, leaving only about 0.05 gram of undissolved selenium on the filter paper. This gives a solution of 4% selenium content which was diluted 1:20 to produce the 0.2% reagent. Selenosulfates are analogues of hypo and have the formulas Na_2SeSO_3 or K_2SeSO_3.

Selenium toners are commercially available and, for example, the Kodak Rapid Selenium Toner has been found suitable when used at dilutions of 1:9 or greater.

In order to clarify the relative suitability of the possible reagents, they were compared directly on a variety of prints, both fresh and following severe aeration and incubation tests of the reagents. The incubation tests involved keeping in tightly closed bottles for 10 weeks at 120 F, while, in the aeration tests, 100-ml. quantities of the solutions were exposed in open 500-ml. flasks for periods up to 19 days at about 75 F. The hue and intensity of the treated areas were compared with those of the printed steps of the Kodak Hypo Estimator,[4] which forms a convenient guide. In making the comparison, the Hypo Estimator was placed over the print and the spotted areas were compared with the adjacent one by reflected light. This technique makes the comparison independent of the hue of the paper stock. In some cases samples of the prints were also subjected to incubation tests, so that the degree of stain which might be ultimately expected on full decomposition was known.

The solutions examined included:

1. A 2% solution of sodium sulfide.
2. An 0.2% solution of sodium sulfide.
3. A solution of potassium selenosulfate containing 2% potassium sulfite and 0.2% selenium.
4. The Kodak Rapid Selenium Toner, diluted 1:9.

Comparative Properties

1. *Hue.* The hue produced by the sulfide was the coldest and grayest of the group, and was less brown, particularly at low intensities, than the comparison patches of the Kodak Hypo Estimator. The selenosulfate patches were much warmer, and were redder, particularly at high concentrations, than the test patches of the Hypo Estimator. Probably the closest correspondence to the test patches was obtained with the Rapid Selenium Toner.

2. *Intensity.* The spots produced by the sulfide reagents were similar in intensity to the stain obtained with incubated prints. This is a rather low level of

* Research Laboratories, Eastman Kodak Company, Rochester 4, New York. Communication No. 1732 from the Kodak Research Laboratories. Received 1 June, 1955.

Table I

SILVER TEST REAGENTS

	2% Na_2S	0.2% Na_2S	Seleno-sulfate	Kodak Rapid Selenium Toner
Hue (*vs.* Kodak Hypo Estimator)	Grayer	Grayer	Red	Slightly Grayer
Intensity	No. 1 step	No. 1 step	No. 2 step	No. 1 step
Aeration (19 days)	Weak	No activity	OK	OK
Incubation (10 weeks)	Weaker Sludge	No activity Sludge	OK Clear	OK Clear
Baryta Stain	Bad	OK	OK	OK

stain for ready observation when only small areas are spotted and poor viewing light (e.g., uncorrected fluorescent lights) is used. However, it correlates closely with the actual danger involved. The acceptable stain approximated fairly well, except for hue, the lightest patch of the Hypo Estimator.

The selenosulfate produced a more intense stain, and any residual silver was much more apparent, especially at low levels. The intensity of the stain in an acceptably washed print would correspond to the No. 2 step of the Hypo Estimator.

The stain produced by the selenium toner was close to that of the sulfide in intensity and similar to that found when silver sulfide was formed by moist incubation of prints. However, the stain develops somewhat slowly and reaches full intensity after about 2 minutes or even as the spot dries, although the result correlates very reasonably with residual silver as estimated by the sulfide test and by incubations (see also Table I).

3. *Incubation Stability*. Both of the sulfide solutions reacted with the bottle during the incubation described, creating considerable sludge, probably mostly silica. The stronger solution retained its odor and reacted positively to show residual silver; but the more dilute solution had lost both its odor and its reactivity. The selenium solutions both had normal reactivity and were free from sludge.

4. *Aeration Tests*. The resistance of the dilute sulfide solution to aeration was greater than anticipated. It still retained activity following the ninth day, whereas a dilute developer, such as Kodak D-72 (1:2), loses all activity in 3 or 4 days of this type of exposure. However, the dilute sulfide solution had completely lost activity when tested on the nineteenth day, and the stronger sulfide solution was weak in action.

Neither of the selenium solutions was affected by the aeration.

5. *Staining Propensity*. The 2% sulfide solution was found to react with baryta coatings, particularly with glossy surface papers, to produce such an intense pink stain as to invalidate the test completely. Similar "baryta" stain was produced with dilute caustic solutions. The more dilute sulfide solution was sufficiently less alkaline to be free from this staining propensity.

Selenium compounds are subject to acid decomposition, but no tests either here or in the Paper Service Division, of the Eastman Kodak Company, including the use of prints fixed in acid hypo or washed in acidic water, disclosed any tendency to produce stain in the absence of silver.

Table II

COMPARISON OF SULFIDE AND SELENIUM REAGENTS ON VARIOUS PRINTS

		Stain Density (Kodak Hypo Estimator Step) 0.2% Sodium Sulfide	Kodak Rapid Selenium Toner (1:9)
(a)	Kodabromide G, DW	No. 1	Between No. 1 and No. 2
(b)	Kodabromide F, DW	No. 2	Between No. 1 and No. 2
(c)	Kodabromide F, SW	No. 2	Between No. 2 and No. 3
(d)	Royal Bromide F, SW	No. 1	No. 1
(e)	Kodabromide G, DW	Nil	Nil
(f)	Opal G	No. 1+	No. 1
(g)	Velox F, SW	No. 1+	No. 1+

6. *Convenience*. From the standpoint of the photographer, the sulfide solution becomes inconvenient to use if it must be diluted before making the test, and in any case its compounding and odor are objectionable. It seems unlikely that the dilute sulfide solution can be kept in a frequently opened bottle for more than about one month. The selenosulfate solution is convenient both to use and to store but it is not available commercially. The Kodak Rapid Selenium Toner has the advantages of being a stock item, ready for use, and stable.

These various properties are summarized in Tables I and II. It will be seen that the sulfide solution, although most directly correlated with the anticipated stain, is the least satisfactory to use. It is necessary to mix a stock solution which must be diluted down within a few days of making the test, and even the stock solution will have a limited keeping life. It is odorous, and may discolor and sludge, but can probably be refilled by a druggist or possibly by a photographer.

The selenosulfate, although it gives the most intense deposit of the tests, is not readily available.

The Rapid Selenium Toner remains as the best of the test solutions. It is readily available for refilling or original mixing, gives a stain similar in hue to the test patch of the Kodak Hypo Estimator, is used directly, and is stable. It is rather slower to react, and a full two minutes must be allowed before observing the intensity of the stain.

7. *Silver in Film*. Either a sodium sulfide solution or diluted Rapid Selenium Toner may be used to test for residual silver in film. The presence of a little residual silver is of less importance here than in prints, because the only effect of a slight stain in the negative is to cause an increase in printing time, unless it is uneven. However, if, following spotting by these reagents, the stain is equal to or in excess of the No. 2 step on the Hypo Estimator, the residual silver should be considered excessive, and the film should first be immersed for five minutes in a fresh fixing bath and then washed.

8. *Directions for Making Test*. Dilute one part of Kodak Rapid Selenium Toner with nine parts of water. After the customary fixing and washing, place one drop on the emulsion side of a dry or squeegeed print. Remove it, after two minutes, by careful blotting with a clean white blotter or absorbent paper. Any stain in

excess of a very light tint, such as that of the lightest step on the Kodak Hypo Estimator, indicates excessive silver.

Notes

1. The sensitivity can be increased slightly by allowing the area to dry after blotting.
2. The test fails where a very large excess of hypo is present in the print.
3. Other selenium toners than that specified here may prove satisfactory but should be checked before being used.
4. Excessive silver in prints may be avoided by (1) keeping the fixing bath fresh, (2) using two successive fixing baths, and (3) using certain washing aids, particularly Kodak Hypo Clearing Agent.

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SLIDES AND OPAQUES FOR TELEVISION

Willard Libby*

THE TELEVISION INDUSTRY relies heavily upon photography for much of its program material. Although motion-picture films constitute the greatest source of photographic material used, transparent slides and opaques (reflection copy) are used for station identification, commercials, announcements, and titles, and are an important ingredient of live shows as well.

Many of the new stations are in the smaller metropolitan regions or in suburban or even rural areas. Local photographers may well be asked for assistance and advice on utilization of photography in programming, preparation of photographic materials, and even the manner in which photographic materials are properly reproduced by the television camera.

General Practice

Often, a station has been on the air for some time and has set up its own practice preparing a printed list of requirements and specifications to guide the photographer and the artist, as well as the client's advertising agency, in preparing the material. The practice set by one station is not likely to match the practice at another. Where possible, the photographer should suggest to new stations preparing to go on the air practices which, based on his own experience in the field and the information in this article, he feels are photographically sound, economical, and practical. If he is dealing with an established station, he must conform to its procedures, although suggestions can be made.

Some stations use only opaques, either in conjunction with suitable projection equipment or in larger sizes for direct pickup by a studio camera. Other stations use transparent slides in various sizes. Still other stations may have equipment which handles both, but they may have a definite preference for one form over the other. Most of the current pick-up equipment for color transmission uses 2 by 2-inch slides. Some units handle opaques and larger slides.

As far as the original material is concerned some established stations prepare in their own art departments the art work of which the slides and opaques are reproductions. At other stations, art work prepared by an advertising agency hired by the sponsor is closely supervised as to layout proportions, size of lettering, and in several other respects. Close control must be exercised over the original material so that quality and uniformity will be maintained.

The station may then turn all the art work over to an outside photographer for him to prepare the material which is subsequently televised. On the other hand, the station may rely upon outside sources for all of the art work used, but prepare all of the photographic material within its own organization a procedure which has the advantage that it places the control of the photographic quality within the direct supervision of the station.

Televising Photographic Material

Because electronic cameras, projection equipment, and procedures in the television field differ materially from their counterparts in the photographic field, a brief explanation may be helpful. The simplest means of televising a print is to mount it on an easel or copy screen. The print is suitably illuminated, and the studio television camera scans it. Slides can be scanned with the camera by means of a matte box arrangement. A slide is projected on to a translucent screen mounted on a solid platform. The television camera is set up to scan the other side of the screen. This side is also shielded to prevent ambient illumination from degrading the

* Eastman Kodak Company, Rochester 4, New York. Adapted from Kodak Pamphlet No. S-54. Received 7 March, 1955

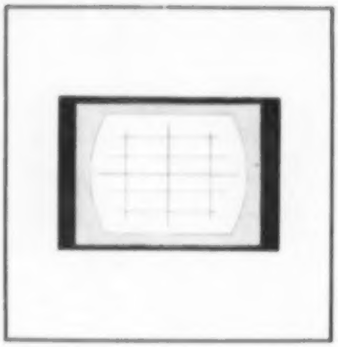

Fig. 1. Exact size template for American Standard 2 × 2 inch slides used in television. The heavily shaded area is the margin of the picture background. Within this rectangle is a lightly shaded rectangle representing the transmitted or scanned area. The clear central area, with curved ends, is not part of the American Standard for Slides and Opaques for Television Film Camera chains but is a recommended "safe area" to allow for misalignment of transmitting and receiving equipment.

image. When such a television camera can be spared, the arrangement can be left set up for all programs which make use of slides and opaques. The photographic quality of the image of the transparency, as seen on a monitor tube or on a receiver in a home, is not as high as that scanned by the special equipment described below, but this system does require a smaller initial investment in equipment. Substituting a field lens for the translucent screen and picking up the aerial image with the television camera lens improves quality.

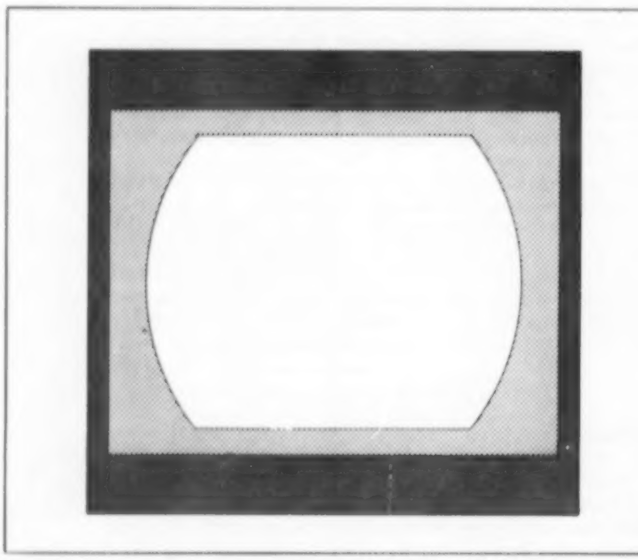

Fig. 2. Exact size template for American Standard $3\frac{1}{4}$ × 4 inch slides used in television. Templates may be photographed on high-contrast film and enlarged to various size to use in layout of art work. For example, art work may be prepared in $6\frac{1}{2}$ × 8 inch size, using a copy of the template in $6\frac{1}{2}$ × 8 inch size to assist in laying it out.

Established and well-equipped stations have a room, usually located just off the control room, where projectors for motion pictures, slides, and opaques are set up, together with a special television film camera or a special pick-up device called a "flying spot scanner." This film studio and the live studio are connected by an intercommunication system so that cues for the showing of slides or motion pictures can be heard by the personnel who operate this rather complex equipment. Several projectors, such as a special form of 16mm or 35mm motion-picture projector, a 2 by 2-inch slide projector, and a $3\frac{1}{4}$ by 4- or 4 by 5-inch opaque projector may all be beamed into one camera by means of a multiplexing unit consisting of movable mirrors on a solid platform. A second camera, with its multiplexer and projectors, may be set up as a standby unit in case of equipment failure or to permit smooth transitions from one reel of film to another. "Flying spot" scanners are also replacing the 2 by 2-inch transparency projector and its associated television film camera particularly for color television transmission.

Uses of Projected Stills

There are many ways in which slides and opaques can be integrated with a live program or actually become the program source itself. Although the photographic characteristics in the stills may differ with the uses to which they are put, these differences are not enough to require sizable changes in the procedures by which they are prepared.

Station Identification. Slides or opaques used for regular station-identification breaks usually consist of lettering on a suitable back-ground.

Commercials. Regular commercials consist of one picture or of several stills presented in sequence. They carry the appropriate art work, photographs, and caption materials. For advertising commercials to be used only at the local level, the photographer may have to arrange for the preparation of the art work, as well as the production of suitable prints or transparencies. Originality on the part of the layout man, good legibility in the important areas of the frame, and a well-planned, logical sequence are all necessary if the commercial is to succeed in telling the story effectively.

Shared Identification. A somewhat specialized type of commercial is frequently used in combination with the station-identification information. The commercial occupies all but one corner of the frame, this corner being used for the station identification.

Announcements. Announcement slides are used for informing the audience of important changes in the program, transmission trouble, and local news events, and for presenting other material outside of normal programming or commercials. These announcement slides usually consist of lettering or perhaps line drawings upon a medium-tone, plain or textured background.

Titles. Title slides are used at the start and end of many programs to introduce the show, to list the characters, to give the credits, to set the scene, and to wind up the presentation. Still frames are used even when the program is on motion-picture film, particularly when the

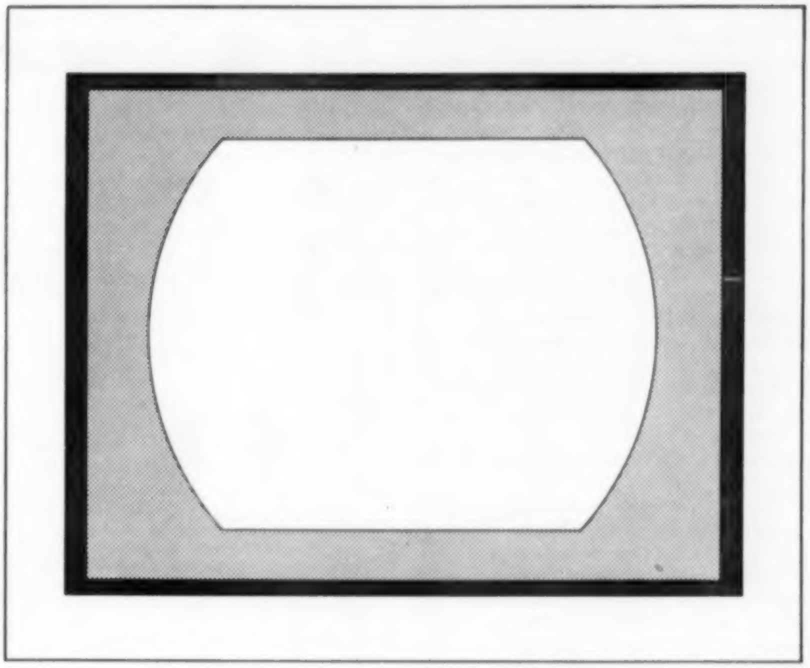

Fig. 3. Exact size template for 4 × 5 inch television slide template. The 4 × 5 inch size is most often used for opaque projection.

program is a local one. With live shows, titles are used to indicate passage of time, to allow for shifts from one set to the next, and to create a change in the tempo or a break in the program.

Projected Backgrounds. Slides have been used in the motion-picture field to create backgrounds for studio scenes. Although some use has been made of this procedure in television studios, there are many factors which make the procedure quite complicated. The photographer should consult the manufacturers of background-projection equipment to determine from them the requirements which such slides must fulfill.

Types of Slides and Opaques

Still material to be televised takes several forms: film transparencies, both negative and positive; color and black-and-white; reflection copy in the form of photographic prints or original art work; material, such as display cards or prints, which can be mounted on an easel or attached to a flannel board and special types of displays, such as moving titles, drums, turntables, and books.

There are several television projectors or scanners in general use. Most of those designed for black-and-white transmission will accept 2 by 2-inch transparent slides directly or with an accessory attachment. Transparent $3^1/_4$ by 4-inch slides can be used in some of the available equipment. Reflection-copy opaques are handled in the 4 by 5-inch size and in the $3^1/_4$ by 4-inch size in different projector units. Strips of reflection copy can also be used in most projectors, either directly or with an adapter. "Ticker-tape" attachments are also available for projecting running titles, usually on film 8mm wide, on any band selected horizontally across the frame. Some units designed for color transmission will accept opaques, but most take 2 by 2-inch color slides.

Special displays made for studio use are picked up by the studio television camera. Large maps, charts, posters, flannel boards, and similar display materials are usually mounted on heavy cardboard, hardboard, or plywood, and the television camera is moved up to cover the display. Obviously, the dimensions for such displays vary greatly, and the only requirement that they should fulfill is that the dimensions of the important scanned area have the 4 to 3 proportion of the television frame.

Preparation of Flat Copy

In the preparation of flat copy for subsequent scanning by a television camera, there are several problems which must be considered.

Safe Area. Photographs and other flat copy prepared for transmission must be made up to the dimensions for which standards have been set. These dimensions obviously depend upon the type of pickup equipment. The drawings shown in Figures one, two, and three conform to American Standard PH22.94-1954 published in the Journal of the Society of Motion Picture and Television Engineers (May, 1954). These drawings are prepared for the purpose of showing the three sets of areas

involved when flat copy, either transparent or opaque, is scanned on a television system. These areas are (1) the over-all size of the slide or opaque, (2) the image or picture-background area, and (3) the transmitted or scanned area. A fourth area, not a part of the standard, called the "safe area," is shown inside with curved ends. Thickness must also be given for slides and opaques.

The picture-background dimensions are those of the opening in the opaque mask or mat in a transparent slide or of the slide-carrier opening in the opaque projector. To avoid white borders and to prevent stray light from entering the television film camera with either an opaque or a mounted slide, the actual picture area should exceed slightly the picture back-ground dimensions.

The transmitted picture dimensions define the area picked up and scanned by the picture tube. As is the case throughout the whole film chain from projector to home receiver, any misalignment or poor adjustment of the equipment will result in loss of area.

The safe area consists of a rectangle with rounded ends smaller than the scanned or transmitted area. Because of the likelihood of home receivers not being properly adjusted and because of the differences in the shape of receiver masks, all of the essential information should be included within the outside limits of these safe-area dimensions. These values have been determined on the basis of a somewhat limited survey of home receivers. As a result of this survey, it was found that to insure the important material appearing within the limits of the masks on viewers' screens, the material should be kept within a rectangle having dimensions 20 per cent smaller than the dimensions of the transmitted area. To be certain that the essential information, like lettering, charts, graphs, and important areas of pictures, are kept within the boundaries of this "safe area," the drawings shown in Figures one, two, and three may be copied on process film and printed to the correct size on high-contrast film. This clear film with black outlines can then be laid over the original art work and over the ground glass of the copy camera.

Tonal Range. A television chain, even when it is in perfect adjustment, is capable of transmitting a brightness range of only around 30 to 1. The range of tones picked up on a receiver is more likely to be no more than 20 to 1 because of possible misadjustment of the receiver controls and of the general room-illumination level which affects the maximum black on the tube. Because many average subjects have a brightness range of 160 to 1 or even greater, it is apparent that for these subjects considerable compression of tone is necessary in the opaque or slide which is made of them. Of course, a subject having a considerable brightness range is either compressed in tone or loses certain detail when photographed on film, particularly if the negative is printed on paper. The maximum range of tones which can be obtained on a photographic paper with high gloss is less than 1 to 50. For a matte or semimatte paper, the maximum range of tones is approximately 1 to 20 or 1 to 25. With transparent positives, the range is usually greater than that reproduced on any reflection material.

In the preparation of copy to be televised, it is preferable that the tonal range of the copy does not exceed the 20 to 1 range which the television chain can handle readily. If the tonal range is exceeded, then the camera-

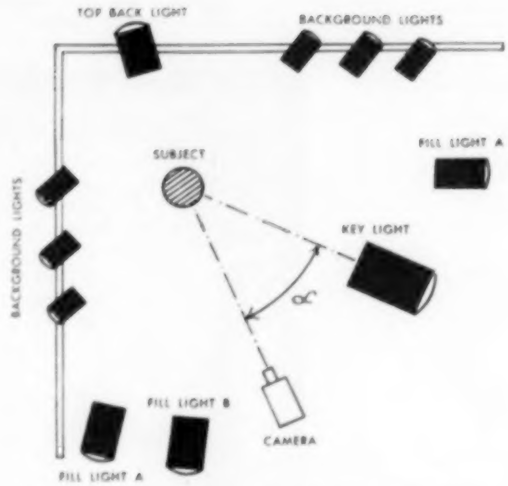

Fig. 4. Lighting diagram for television still pictures. The key light is a 5000-watt Fresnel placed at an angle less than 45° from the camera axis and at a higher elevation. Fill lights are 2000-watt or 5000-watt Fresnel lamps. Lamp A is at eye level, Lamp B is below eye level. The top back light is a diffused 2000-watt or 5000-watt Fresnel. Background lights are diffused or not, depending on the effect desired, and are 750-watt or 1000-watt Fresnel lamps mounted on the top of the scene flats.

chain video operator must select and operate within certain limits of the available range. The desired range can be obtained by (1) controlling the lighting, (2) controlling the subject reflectances, and (3) handling of the photographic materials.

Lighting. For a person or some single object, such as an appliance, low-contrast, portrait-type lighting will give the proper ratio. The fill light is usually located at the camera and illuminates all areas seen by the camera. The main or key light, at an angle to, and usually higher than, the camera, illuminates the highlights of principal interest in the subject. The amount of illumination from these two sources is measured with a photoelectric exposure meter equipped to read incident light. The total illumination reading is obtained by pointing the meter halfway between the key light and the camera. The fill illumination is measured with the key light off, by pointing the meter at the camera. The ratio between these two values, that is, the lighting contrast, should be about 2 to 1.

The illumination on the background is usually provided by other lighting units. The amount of light from these units can be varied as desired, but usually it should not exceed the level on the principal subject from the fill light alone. With subjects in which the range of tones is restricted, such as a white-enameled refrigerator, a dark-colored television set, or a food display, the subject brightness ratio can be increased by increasing the contrast of the lighting to a value greater than 2 to 1. A typical lighting arrangement is shown in Figure four.

For more complicated subjects, such as groups of people, large displays of products, or room interiors, the simple

45-degree lighting is not applicable. In its place, the type of lighting used for live television shows should be substituted. This consists of general over-all room illumination from above and placed low around the edge of the scene. All important parts of the scene should receive approximately the same amount of light. Accent lighting is furnished for the principal parts of the scene by high-intensity spots used at angles of from 45 to 90 degrees to the camera-subject axis. Angles greater than 45 degrees are used to outline the principal subject and so provide a sense of depth and separation of planes. When color film is exposed, the lighting units should be of the type specified in the instruction sheets packed with the film.

Subject. With certain subject material, the brightness range can be reduced by changing the reflectance or eliminating specular reflections. Commercial photographers kill glare reflections of objects like white refrigerators by painting them with a starch solution. It is helpful to include in the picture an object lighter in tone than the principal subject so that the controls can be set for that object.

Photographic Processing. When the black-and-white prints are processed according to the recommendations in the section "Photographing the Art Work," they appear somewhat gray and flat by conventional photographic standards. However, they retain important detail and, in some regions of the scale, gradation can be increased by suitable dodging.

Distribution of Tones in Black and White. In a black-and-white television film chain, there may be difficulty with streaks when large areas which differ greatly in brightness are side-by-side in the scene. Because of the characteristics of the iconoscope tube particularly in some of the older installations, streaks or smears may occur to the right of the light-dark boundary. There may also be an edge effect which looks like camera flare. This latter effect is particularly noticeable in the dark areas in the lower and right-hand borders of the picture area. No value can be stated which describes the density at which this effect will take place. It is influenced somewhat by the size and location of light and dark areas within the picture frame and also by the effect introduced by the shading controls. If the density range is compressed to within the specified values, the likelihood of encountering trouble from this cause is reduced. To insure maximum freedom from the edge-flare effect, avoid having dark areas in the lower and right-hand regions of a frame when laying out art work and photographs.

Use of Color. Color is used frequently in preparing art work for both black-and-white and color transmission because of its greater appeal to the client and the art director of the agency. Cartons, labels, and other material may also be scanned directly without first being photographed. Because, under the different light sources which are customarily used, the color sensitivity of the black-and-white pickup tubes can be corrected to match that of the human eye, no unusual problems are encountered as a result of using color. However, the various paints, papers, and colors in common use should be checked on the television chain to determine how they reproduce. If much flat copy in color is prepared, it may be desirable to select samples of all the colored material to be used and compare each sample over the black-and-white television chain with a reference scale of grays. The gray scale should have about nine steps ranging from white to black. Once these tests have been carried out, each piece of color material can be arranged in chart form or assigned a letter or number to show the step of the gray scale to which they most closely correspond.

Naturally, any tests of this type must be made with the regular transmission filters over the lens of the TV camera. Where at all possible, the filters used should be those recommended by the manufacturer of the pickup tube for converting the spectral sensitivity of the tube to that of the eye. There are times, however, when filters are not used over the camera lens because of their great absorption of the light falling on the sensitive surface of the tube. To prevent infrared radiation from adversely affecting the quality of the transmitted image, infrared absorbing filters are used. When filters are changed or removed, the relative brightnesses of the various samples will have to be redetermined.

When flat copy, a scene or a live subject is photographed on color film for color television, consideration is needed in selecting the colors. Very dark colors, as might be used for draperies or colored paper used as backgrounds in artwork require extra illumination in order to prevent the received image from appearing black and without detail. If the color reproduction of a particular object or advertiser's product is important, actual tests should be carried out using the paints, pigments, and inks to determine how the colors will appear on the receiver. With existing color films, blues and greens tend to reproduce slightly darker than they appear and the overall contrast increases. The reproduction of colors in a transparency by a color television system is relatively accurate with the existing equipment. However the most commonly used objects, colors and materials should be photographed and viewed on a closed system before extensive use is made of the material.

Visibility Standard. The lettering for titles and lines placed on the art work should be much heavier or bolder than is normally used on flat copy intended for other purposes. As is the case with any advertising, the import of the message must be readily grasped by the viewer at almost a single glance. Bold letters will gain and hold attention when fine lines, which do not stand out, will not be read. In addition to the need for attention-getting characteristics, the lines need to be heavy because lines which are too light will not be resolved by the television chain. Although a resolution of up to 450 lines per frame is theoretically possible, the number of lines that can be resolved across the face of the receiving tube, under practical operating conditions, seldom exceed 300. Thus, lettering which is too small and too thin will be lost.

Lettering should be at least $^1/_{20}$ the height of the frame. Smaller lettering will not usually be visible. Captions, one- or two-line titles and any other non-text material should have letters at least $^1/_{20}$ of frame height. When the iconoscope is used for black-and-white pickup, the tone of the lettering background should be medium gray, preferably broken up with a herringbone or texture pattern to minimize smear. Black backgrounds will cause the undesirable halo or edge-flare effect. Where the letters

are large, a reduction in the amount of horizontal smear can be effected by shading the letters so as to decrease the density toward the right. A narrow black border around the right edge of each letter serves the same purpose. This effect can be produced by using letters with a definite thickness such as the plastic or ceramic letters meant for movie titles. The lettering is illuminated with a fill-light at the camera and a spot located at approximately 45° to the camera-to-copyboard axis so that a shadow is cast on the right side of the letters.

Legibility in color transmission is influenced by the relative brightness of the lettering with respect to the background and by the contrast in hue and saturation of the colors used. For example, a tan or a brown might not be as legible as a dark blue on a tan or a red on a medium green background. Tests with the materials to be used on a closed chain will enable the artist to evaluate legibility and effectiveness of the prepared material.

Photographing Flat Copy

Standard copying procedures are followed. The reader is therefore referred to other publications for more complete information than is given here on copying equipment, exposure, lighting, and handling the materials used.

Equipment. When black-and-white positives are made by contact from the negatives, a 4 by 5-inch camera is recommended. Excellent results and a considerable saving in time are possible if a copy stand is made. To center the copy, horizontal and vertical lines are ruled on the copy board so that they intersect on the lens axis. The midpoints of all four edges of the copy are marked. When these marks are directly over the ruled lines on the board, the copy is centered.

Two reflector-type photographic flood lamps on tripods or arms attached to the copy bench provide a very satisfactory means of illuminating the copy. It is preferable to locate the lamps so that they will illuminate evenly the largest copy to be handled. No change in exposure will then be needed for copy of various sizes, except for that required by differences in the change produced in the effective lens aperture by the lens-to-film distance, or "bellows extension," as it is frequently called.

Color slides, 2 by 2-inch, can be made on transparency films balanced for artificial light.

An ordinary 35mm camera can be used, focused by a supplementary lens and mounted in a vertical set-up, if the copy is uniform in size. Single lens reflex cameras or adapters which provide ground glass focusing are more convenient to use for this purpose, particularly wherever the copy varies in dimensions.

Exposing the Film. For copying the art work, brilliant gradation sheet film and roll film (35mm) are recommended. Positive, 2 by 2-inch slides are obtained directly, often with some saving of time, by using Kodak Direct Positive 35mm Film in the camera.

The manufacturer's instructions for using a photoelectric exposure meter for copying should be followed carefully in determining lens and shutter settings. To these the change in the effective aperture produced by the short lens-to-copy distances should be applied unless the lens was focused by the use of supplementary lenses.

The negative films should be processed in accordance with the manufacturer's instructions to yield a relatively low-contrast, "portrait-quality" negative. The Direct Positive Film should be processed in solutions made from the Kodak Direct Positive Developing Outfit.

Making Black-and-White Opaques. Where possible, prints should be made by contact. If the negatives have been made by outlining on the ground glass of the copy camera the area to be covered and by including only that area on the negative, then no further cropping of the image size is needed.

Opaques are usually made on a white or cream-white, smooth, double-weight paper. Whenever possible, an unferrotyped, glossy paper should be used because of the increased brilliance in highlight areas obtained on the receiver. However the choice of the surface sheen or gloss of the photographic paper is governed by the type of television projection equipment used. Unless the opaque slide can be bound up with a sheet of light cardboard on the back and a piece of thin glass, like Lantern Slide Cover Glass, on the face, the print will buckle under the extreme heat of the projection lamps. If a glossy or lustre-surfaced paper buckles, specular reflections from the surface of the paper will cause glare spots in certain areas of the televised image. Therefore, if the slide carriers of the equipment cannot accept an opaque which has been mounted so as to prevent buckling, a matte paper must be used.

If the range of densities in the negative yields a brightness range in the opaque in excess of 20 or 25 to 1, then the effective density range of the negative must be compressed as it is printed. In order to do this retouching dye (neo-coccine) can be applied to areas of the negative where the exposure on the paper must be reduced. Selected areas of the negative can be made to print lighter or darker than normal by suitable dodging techniques.

Prints for use in an opaque projector should be kept light in order to gain as much illumination as possible on the face of the iconoscope tube. However, great care must be exercised in order to maintain highlight gradation through the selection of the proper grade of paper and by suitable dodging, particularly in the shadow regions. In making prints to be televised with an image orthicon camera, a higher exposure level can be used. Except for any specular reflections, such as catchlights in the eyes or mirror reflections from a polished metal surface, the highlights of a processed print should be darker than the paper stock. In other words, the print should appear soft, slightly dark, and somewhat overexposed.

Making Black-and-White Slides. The transparencies should be made by optical printing with an enlarger or copy camera. The effects of dust, dirt spots, and scratches tend to be subdued in the slide, particularly if some diffusion is present in the illumination system. For 2 by 2-inch slides on glass, Lantern Slide Plates are recommended. If film transparencies are needed, then Fine Grain Motion Picture Positive Film, which is available in 100-foot rolls, should be used. For larger transparencies, $3^1/_4$ by 4-inch Lantern Slide Plates, Commercial Film or Kodak Commercial Plates are suitable for making positive transparencies.

A 35mm copy camera, should be loaded with postive film to make 2 by 2-inch slides on film from the negatives.

The negatives are illuminated from the rear by placing them over an illuminator or a light box which has been made for the purpose. For $3^{1}/_{4}$ by 4-inch or 4 by 5-inch slides an enlarger is needed. When the positive film or plate is exposed, a jig should be used to hold the material in position so that the projected image is centered on it.

The positive material from normal negatives should be processed for the time specified in the instructions packed with the film or plates. The slides should be examined in a manner similar to that recommended for judging color transparencies. Place a sheet of white paper on the desk or table and illuminate it with a lamp with a shade which prevents the rays from the light bulb from reaching the eyes directly. Hold the slide at such an angle that the light is reflected from the paper, passes through the slide, and then reaching the eyes. Make certain that light from the lamp does not fall on the side of the transparency toward the observer. A slide examined in this manner should have good detail visible in the whole density range. No area except specular highlight areas should be completely transparent. Slides made from negatives of scenes with too great a range of brightnesses should receive less than the normal developing time in order to have them televise well.

If possible, slides as well as opaques should be evaluated by actually examining them over a closed circuit television chain. By comparing their appearance with that of a group of stills of the same subject which have received different exposures or developing times, the one which gives the best results can be used as a guide.

Mounting the Positives. Reflection prints should be trimmed carefully to insure that their images will be accurately centered on the tube when the prints are mounted in the carrier mechanisms of the different projectors. Some equipment uses a long carrier which holds several prints at one time. Thus, the operator can visually center the images in the carrier openings. Other equipment allows little time for positioning the opaque copy, so that proper trimming is important. If copy is not centered accurately, the upward, downward, or sideways shift of the televised image is disturbing to the viewer when dissolves are made from frame to frame in the projector.

When 35mm film is made up into 2 by 2-inch slides, it is also extremely important to have the image centered accurately in the scanned frame. Because of the relatively small image size of these slides, positioning must be undertaken with even greater care than in the case of the larger frames. A centering jig should be constructed to facilitate the mounting operation. This jig consists of a sheet of ground glass illuminated from the bottom, a rectangle drawn on the glass to indicate the limits of the opening in the mask, and a set of pins which serve as edge guides for the glass. (Kodak Masks for Glass Slides have an opening which is larger than the scanned area.) A 2 by 2-inch sheet of Slide Cover Glass is placed on the illuminated ground glass, the transparency is centered in the mask opening, and the two are aligned with the rectangle on the ground glass. The second sheet of cover glass is then put in place, the combination is picked up, and the edges bound with tape.

Transparent Prints. Transparent prints made on Kodak Translite Enlarging Paper have several advantages over slides or regular reflection prints. When prints on Translite Paper are illuminated from the back and scanned with a studio television camera, the transmitted picture is generally of better quality than when reflection prints are used. Through the use of a large print the studio camera can be used for scanning stills as well as for live pick-up thus eliminating the need for a television film camera and its associated equipment.

Prints on Translite Paper can be made to any convenient size such as 8 by 10 or 11 by 14 inches by regular enlarging procedures. There are no special processing or mounting procedures required. Information on the handling and processing of the paper is given in the instruction sheet packed in each box.

A light box is used to illuminate the print from the back. The opening in the box should be slightly larger than the largest print which will be used. To keep heat to a minimum, fluorescent lamps rather than tungsten lamps are recommended. Masks of heavy cardboard should be used to block off stray light around smaller prints which do not completely fill the opening in the illuminator.

Black-and-White Transmission of Color Slides. Color transparencies of scenes lighted with a ratio of 2 or 3 to 1 televise well provided infrared radiation from the tungsten source is removed by a suitable filter. The effect of this radiation on the iconoscope and vidicon pickup tubes is to reduce markedly the quality of the transmitted image. Experiments with a number of infrared absorbing filters have shown that considerable improvement in the transmitted picture results when a 6 millimeter thickness of Pittsburg No. 2043 Glass (tempered) is used in the condensing system of the slide projector. This filter glass may be left in the light beam of the projector when black-and-white slides are televised without perceptibly degrading the picture quality of the transmitted image. Although a second filter in the projector is recommended for motion picture film pickup and, in the past, a second filter has been recommended for slide pickup, at the present time the quality of the televised still picture does not seem to be improved appreciably by the use of this second filter. Therefore, the Pittsburg No. 2043 Glass alone should be used for color as well as black-and-white still pickup.

These recommendations apply specifically to reproduction with an iconoscope or vidicon pickup tube and tungsten light source. There is no comparable problem at the present time with existing flying spot scanners.

Use of Negatives. By a slight adjustment in the electronic circuits associated with the iconoscope tube, it is possible to scan a negative image and yet produce a positive image in the viewing screen. There may be instances, such as when time does not permit the preparation of a positive, when it is desirable to employ this type of transmission. Because the television-chain response characteristics vary somewhat with the over-all density of a transparency being scanned and the distribution of light and dark areas in the frame, the change from a positive to a negative would require a repositioning of the shading controls. Generally, it is preferable not to make use of negative for transmission because of this repositioning problem, particularly if one or only a few negatives are used in conjunction with a larger number of positives.

TELEVISED ART WORK, PHOTOGRAPHS, AND TRANSPARENCIES

Elmer S. Phillips*

BECAUSE OF the special shape of a television screen, not everything in art work, a photograph, or a transparency may show on that screen. The visual aids office is standardizing the sizes and shapes of photographs and art work that go from The College of Agriculture to television stations. If these dimensions are consistent with the policy of the station over which the reader telecasts, the office suggests that these same standards be followed by others when picture material is prepared for televising.

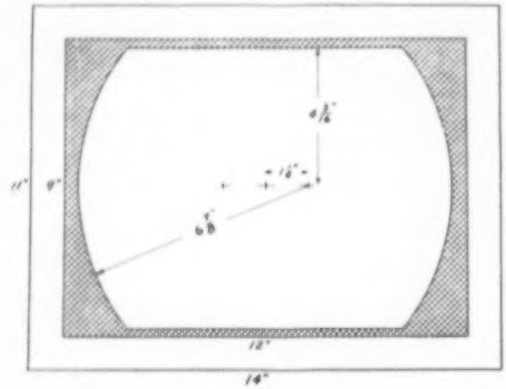

Fig. 1. Layout for 11 × 14 inch picture format for television use adopted by the Visual Aids Service, Cornell University. Photographs as well as art work can be prepared to fit this format.

The College of Agriculture plans to make all art work and to mount all photographs on an 11 × 14-inch cardboard as most of the first shaded area inside this 11 × 14-inch cardboard (marked 9 × 12 inches) should be picked up by the television camera. Because screens differ in shape, only that portion of the material shown by the white area can safely be relied upon to be seen by the viewer.

A piece of cardboard in which two crescents have been cut at each end is shown in Figure two. The outside dimensions of the shaded area are 11 × 14 inches, and the line indicated by the arrows is the same curved line shown in Figure one to indicate the limit of vision. This is the template used to prepare art work. Lay this template on an 11 × 14-inch cardboard. Then with a pencil, lightly follow the outside curve of the crescent (indicated by arrows) to mark the limit of vision on the cardboard.

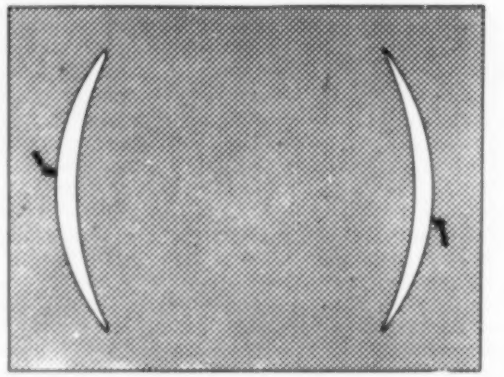

Fig. 2. Template for laying out art work and photographs on 11 × 14 inch cards for television use.

How art work can exceed this safe area should the camera be slightly off center, or perhaps the receiving set slightly out of adjustment, is illustrated in Figure three.

An appreciable amount of art work could make the picture still more attractive. The pale cross-hatching has been retained in Figure three merely to show the 9 × 12 inch area, and the safe area inside. It is normally no part of the drawing.

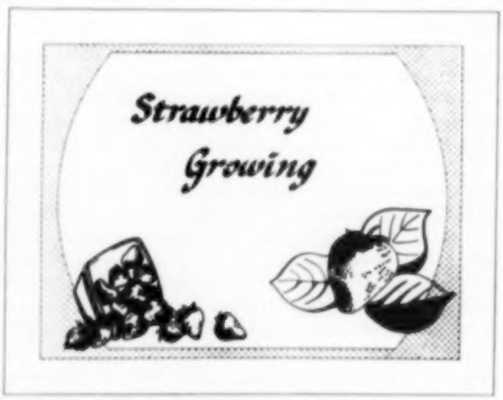

Fig. 3. Cornell University television diagram showing the picture area falling within a 9 × 12 inch area centered on an 11 × 14 inch card with a clear area designating the portion that will always be shown on a home receiver.

* Department of Extension Teaching and Information, Visual Aids Service, Cornell University, Ithaca, New York. Received 25 January, 1955.

MACROPHOTOGRAPHY OF MOSSES AND LICHENS

Herbert H. Holliger*

THE FIELD of macrophotography in black and white is very interesting and the technique is rather simple. But when color film is used, when the objects to be photographed are round or oval, when they are more beautiful wet than dry and polarizing filters are used and crossed; the problems indeed become involved and certain compromises must be accepted.

The compromise is very easily stated. A large sharp picture of the important area is necessary and certain unimportant areas have to be accepted out of focus. In the use of material that is cross-sectioned by grinding and then photographed, there is only the flat surface to be photographed, so the amount of magnification can be high and is easily managed. Many small objects in the field of botany are round or oval. When photographing a round object—obviously only one-half of the object, that half facing the camera, appears on the film, so the thickness of this visible half indicates the maximum depth of field. Preliminary focusing can be done with the lens wide open, but final critical focusing must be done with the lens stopped down to the taking aperture with a reading glass in a darkened room. Only in this way can the best possible compromise be arrived at. A reasonable amount of luck and experience is helpful.

When photographing peristomes of Byrophytes these round objects are viewed from the end of the capsule, since much very fine detail is present here. In this case only about one-half of the visible area can be in focus; the remaining half is less important. By this compromise the best possible demonstration of the peristone teeth has been achieved. The taking aperture, of course, is not the smallest available on the lens being used, but nearly so.

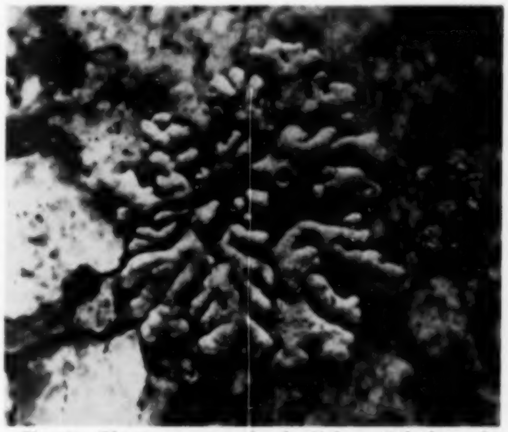

Fig. 2. Photomacrograph of a lichen, *Caloplaca elegans*. The original 4 × 5 inch color photograph was used to make a 14 × 17 dye-transfer print at 52 diameters magnification. This lichen, orange in color, is growing on a blue-green stone. The specimen was made wet with water and photographed through crossed polarizers. The lens to film distance was 16 inches. The one-inch equivalent focus lens was stopped down to f/11.

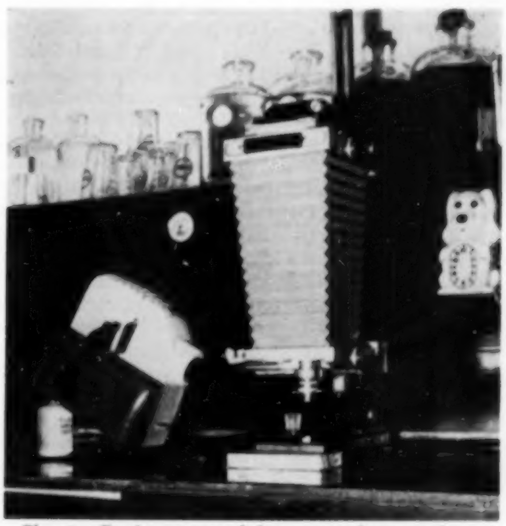

Fig. 1. Equipment used for macrophotography. A 2 × 2 slide projector provides a useful source for concentrated light. It may be moved to the opposite side of the specimen—after one side has been illuminated and exposed—to expose the other side, since the subjects are generally inanimate and rather long exposure times are required. The darkroom clock is not as silly as it looks. The eyes of the dog, visible in the dark, rotate from side to side at one second intervals, which aids in measuring exposure time.

The photograph in Figure one illustrates the type of equipment that is suitable. Frequently focusing is finished by moving the entire camera. Vertical adjustment of the camera is a necessity.

A 750- to 1000-watt bulb is used in the projector and this light source is, in the hands of those who own only one projector (and that is most of us) moved from one side to the other for one film exposure. Any tinting of the heat resisting glass is seriously detrimental. A projector as a light source can be easily polarized by use of a 2 × 2 polarizing filter in the slide carrier. Time exposures up to ten minutes on each side of the subject have been successfully used. Exposures beyond that time lose value.

Lenses and equipment can become quite warm but hot lenses that can be easily held in the hand have not, in my personal experiences, been damaged, probably due to the slow rate of heating and cooling.

Lens equipment is varied, focal lengths used being as short as 16mm. These different lenses require an assortment of extension tubes, etc., for attachment to the lens board. Ground glass focusing is, of course, essential,

* Huron, Ohio. Presented at the PSA National Convention in Chicago, Illinois, 6 October, 1954. Received 28 February, 1955.

but a light-tight attachment for the top of the camera is not only difficult to arrange but unnecessary. A cloth can be placed on the top for the exposure and the necessary darkened room will be sufficient to stop light leaks.

Lens to film distances of thirty inches have been successfully used with a 16mm lens. At this magnification, the depth of field is very critical and focusing difficult. When using a magnifying glass for focusing on the ground glass, details of the ground glass can interfere with accurate focusing and it is well, after making a difficult set up of material, to spread the focus and time over anywhere from four to eight shots. At times twenty to thirty exposures appear inadequate.

Many objects of interest for photographing are shiny. Others are made shiny by wetting them with water because they appear at their best when wet. Many objects have only slight variations in color. All of these situations are benefited by photographing through crossed polarizers. This type of lighting results in an increase in contrast between colors and an increase in exposure factor, stated to be from 25× to 50×. Actually, this is close to being correct, but more is involved. A different exposure is required for light and dark subjects at the same distance. This variation may be as much as 15 times more for a dark subject, than for a light subject.

With the addition of polarized light, a change in the color temperature occurs, which requires color correction filters. The use of these filters carries about a 2× exposure factor which increases the already troublesome exposure problem. Probably the use of these CC filters is not indicated except with very light subject material.

Excellent color prints can be made by the dye transfer process of materials photographed with polarized light. A CC filter is necessary with light material photographed on color negative material. Not the same filter as used with Kodachromes. A gray card and a white card need to be photographed on the negative, but the gray card is not an accurate indicator of the correct exposure. This is because of the range in exposures between light and dark subjects. A little luck and experience are also useful here.

AN f/SYSTEM SLIDE-RULE FOR PROCESS PHOTOGRAPHERS

Robert R. Erwin*

THE SLIDE-RULE shown in Figure one is designed to provide the photographer with a means of setting his lens aperture to maintain a constant ratio of lens-opening to camera-extension over a wide range of enlargements and reductions. By selecting an f/stop (on the movable scale at the left) known to be correct at same-size, the correct f/stop values will line up opposite the other percentages of enlargement and reduction (on the center fixed scale) within the range of the rule. For example, if f/45.3 is set on the 100% (same-size) line, f/58.7 will be correct for a reduction of copy to 54% of same-size, and f/19 is the stop indicated for an enlargement to 378%. By selecting f/27 as a same-size aperture and setting it opposite the 100% line, for example, the opening for 54% would then be f/35, and at enlargement 378, it would be indicated as f/11.3. This holds true for any setting within the range of the rule. The movable scale on the right in Figure one tabulates the numbered apertures that appear on a Douthitt Rotating Flash Stop. By measuring the numbered stops, one finds that they range from a diameter of .250 inches (#20) to .037 (#3). The presence of #2$^1/_2$ and 2 is hypothetical. As the numbers of the stops double, their diameters double; that is, #4 measures .050 inches, #8 is .100 inches, and #16 is .200 inches. By setting up the flashstop numbers in a logarithmic spacing, and co-ordinating the total length of the flashstop scale with the spacing of the f/value scale, the apertures increase at the same rate. In the example cited earlier, where the left-hand f/value scale is set at f/45.3 at same-size (Figure one), and flashstop #5 set on the right-hand scale, #4 is the nearest indicated flashstop for 54%, and #12 is nearest for 378%. It can be seen that where the lens aperture doubles, the number of the flashstop doubles also, as f/90 is opposite #2$^1/_2$, f/45.3 lines up with #5, and f/22.6 with #10. Any other setting of a flashstop number would act the same.

The slide-rule is calculated on standard data gathered from a wide variety of sources, but most valuable of the references is that excellent book, "Process Photography and Plate-Making," written by Joseph S. Mertle, and published by the Cramer Dry Plate Company. Mertle has advanced a system to indicate quarter-division changes of f/stops at regular intervals of size. Efforts have been made with the present instrument only to interpolate eighth-stops, with the corresponding closer intervals of percentages of size. Where, for convenience and clarity, Mertle's quarter-stop intervals are marked f/22, f/22a, f/22b, f/22c and f/32, the purposes of the slide-rule seemed better served by using f/22.6, f/24.7, f/27, f/29.3 and f/32, etc. The subdivisions in eighth stops may be too close for practical purposes, but are there for those who can make use of them. Incidently, for the technically minded, as the sequence of f/numbers 8, 16, 32, 64 and 128 is arrived at by multiplying successively by 2, and the series 8, 11.3, 16, 22.6, 32, 45.3, etc. by multiplying by the square-root of 2 (1.414), the intervals on the slide-rule are arrived at by finding square-roots of square-roots down to a final factor of 1.04375.

* 165 Woodbury Avenue, Springdale, Connecticut. Received 25 April, 1955.

Going back to the flash-stop scale, of course any number selected and set is only correct in that relationship for a lens of a given focal length. If #11$^1/_2$ were set at same-size, and a 19 inch lens is used, it would have an effective aperture of f/132 (#11$^1/_2$ measures .1437 inches, and has about that value with a 19 inch lens), but with a 16$^1/_2$ inch lens a #10 flashstop would give the same relative aperture, and #14$^1/_2$ would maintain the same f/132 with a 24 inch lens. The above, of course, refers to f/numbers as they are marked on the iris ring, where they apply when the lens is at focus for infinity; at two-focal-lengths camera extension, or same-size, the marked f/numbers have only half their nominal value, and one-quarter the area. The method of using the sliding left-hand f/value scale and the center percentage scale would not change with lenses of varying focal length, but the unit flashstop would have to be re-selected to maintain the relationship between iris and flashstop, as noted above.

The selection of the proper lens opening is a highly controversial subject, and it is not within the scope of this article to advocate any particular system. The same book, "Process Photography and Plate-Making," by J. S. Mertle, goes into the subject very thoroughly, and outlines a very comprehensive and workable system for screen negative making by the diffraction theory first advanced by Arthur Fruwirth. Many photographers have one, two or three stop systems that they find fit their needs. So, the selection of a unit or same-size stop is up to the individual operator, but the slide-rule can maintain the lens opening camera extension relationship once the unit stop is set on the rule.

Camera manufacturers have been putting focusing scales on their cameras for years, with extensions of the iris diaphragm markings. These extensions consist of a semi-circular flat plate attached to the lens barrel, marked with concentric lines describing an arc of about 90 degrees, and bearing numbers for setting the lens openings in relation to the camera extension. A ring with blade is attached to the iris control ring of the lens to complete the unit. All of these systems are excellent for the purpose, and the photographer who has one usually has no troubles that can be blamed on that particular mechanism. However, if the system is based on an arbitrary code of numbering the percentages of enlargement and reduction, and the lens scale bears numbers following through with that system, the operator will be at a disadvantage if he has to work on another camera using a different system, or one with no system at all.

Some lens and camera co-ordinating systems are in percentage and actual f/value markings, and the camera operator used to this condition would have little difficulty in making a change to another camera, with whatever system it is scaled. The eighth-stop intervals of the slide-rule cannot be set on diaphragm control scales marked with arbitrary scale numbers, but can readily be transferred to one that has the f/values either as a continuous series of f/numbers, or the conventional f/system stops subdivided into quarters. The operator whose lens scale is marked with arbitrary numbers can add another line bearing the actual iris diaphragm values. Those with the process lens just as it comes from the manufacturer can, with a bit of engineering, construct a lens-opening extension scale themselves.

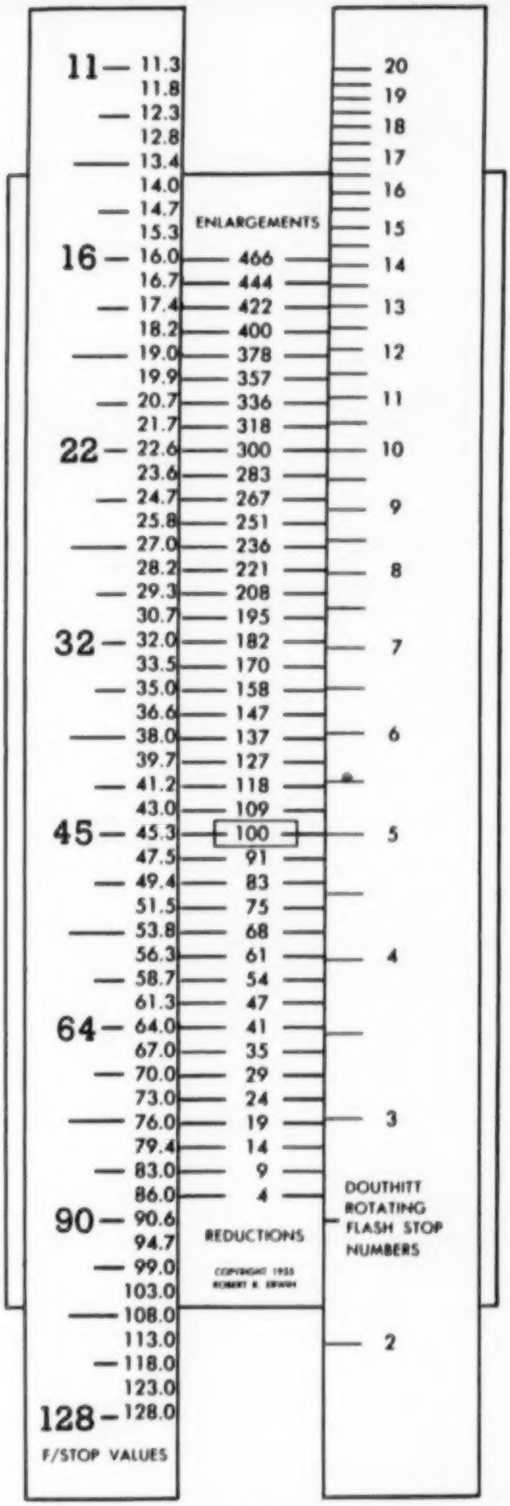

Fig. 1. Slide rule adjusted for 1:1 copying at f/45.3 gives correct f/stop to use for various enlargements or reduction from the original size. The right-hand moveable scale is used for selecting the proper Douthitt Rotating Flash Stop when making photoengravings.

The photographer should bear in mind that a process lens is an expensive and delicate optical instrument, adjusted with the precision necessary to do the critical job for which it is designed. Any heavy-handed tinkering will result in damage to the lens, and will not improve relations between the photographer and his employer. Plan every move with care. There are many lenses today with scaling systems, and one can copy the parts from existing models available nearly everywhere. Care should be taken not to constrict the iris control ring of the lens when attaching an indicator blade, and when putting any encircling band around the lens barrel. Only enough tightening to assure freedom from slipping should be applied. In verifying the accuracy of material for this article, lens manufacturers were consulted to find the method of spacing the series of conventional f/number markings over the span of the projected arc of travel from largest opening to smallest. An examination of commercial expanded diaphragm-opening lens scales (and four different focal-length lenses were measured, all from the same maker) indicates that the scales are correct on each lens, but the scales are not by any means interchangeable. Copying the scale made for one lens and trying to fit it to a lens of a different focal length will not work, as neither the segment of arc nor the proportionate spacing between f/values are the same. The lens manufacturers state that no regular formula applies, and that each lens division is calculated separately. There is scant mention of the problem in most literature available, but I. H. Sayre, in "Photography and Platemaking for Photo-Lithography" describes the method used. Four different lens scales were attempted by those directions, and the resulting divisions compared with those on the four lenses. The divisions coincided.

If the reader would like to try doing this, he should get several 17 inch by 22 inch sheets of cross-ruled paper; ten divisions to the running inch is most convenient. A horizontal line 12 inches long is drawn about one-third of the way down from the top of the paper, centered from side to side. Subdivide the line into six parts of two inches each. This will give six divisions with twenty units to each division. Each unit will serve as a half-decimal. Starting at one end number the six divisions as follows: 60 50 40 30 20 10 0. This will be sufficient for lenses up to 19 inches focal length. Add another division for lenses 24 inches and over. For example, using a 19 inch lens, f/11.3 has a diameter of 1.6814 inches. Using a factor of 3X to amplify it for plotting on the horizontal scale, the figure is now 5.0442. Place a short vertical line on the linear scale at this position. Find the diameter of the smallest marked lens opening, and multiply that by the same factor of 3. If f/90.6 is the smallest opening, the horizontal scale is then marked at .63 (.2095 × 3). Disregard figures beyond two places to the right of the decimal point. Now go back and position the intermediate f/values required on the lens scale by using the method outlined above. It will be noticed that the division for f/22.6 falls halfway between f/11.3 and the end of the scale; other "doubles" will do the same, as f/16, f/32 and f/64. Just be sure to measure from the zero at the end of the scale, and not the f/90.6 mark.

Having the linear scale divided as accurately as possible, direct attention back to the iris control mechanism.

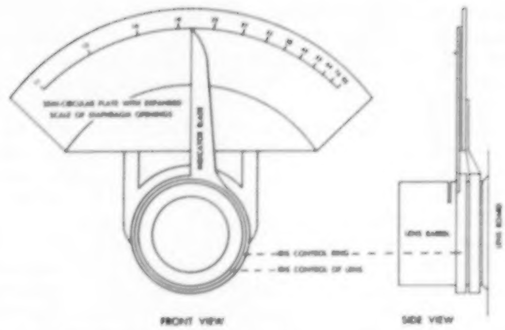

Fig. 2. Supplementary f/stop scale for using the 1/8 stop intervals given in the slide rule calculator.

With a pencil held against a point on the indicator blade that is attached to the iris control ring, swing an arc from one side of the semi-circular plate to the other. An arc whose radius is about six inches should be ample, because the flat plate that will later contain the lens scale must be low enough not to interfere with camera movements, or make it difficult to remove the lens with the lensboard. Mark off the extremes of movement at each end of the arc of travel (f/11.3 to f/90.6), and point off some of the main lens aperture divisions, as f/16, f/32 and f/64. With a flexible rule measure the distance over the curved line from f/11.3 to f/90.6.

Make a line negative reduced to this measurement over the same points on the linear scale that has been drawn. Print the negative on water-resistant base photographic paper, cut the portion with the scale into a narrow strip, and mount it on a thin strip of plastic or metal. Have an assistant bend the strip so that it matches the arc made on the diaphragm control plate, and coincides with the previously made marks at the ends and check points along the arc. If the diaphragm-opening numbers should start on the opposite end of the arc, just turn the strip end-for-end. Should the size of the print of the scale have been miscalculated, make a larger or smaller arc on the semi-circular plate to fit the scale. Be sure that in bending the metal strip bearing the scale, to closely follow the arc. The divisions on the linear scale can now be transferred to the arc. Of course the linear scale is at a right angle to the surface of the plate, and one will need the services again of the nimble-fingered assistant while the scale divisions are transferred. The neatness and accuracy of the scales and mechanism is strictly up to the operator, and they will reflect whatever care and time is put into the project. Use a temporary print of the scale on the diaphragm control plate for a short time to make sure everything is working well, and then make a more permanent set-up. See Figure two. Readers of this publication may copy the illustrations to make a slide-rule for their own use. A number of different models have been made by the author up to now and a standard design evolved suitable for producing them in quantity. If anyone wants a ready-made one, they are available. However, the purpose of this paper is to try to pass on to other photographers the results of an interesting search into the sources of information available on lens opening-camera extension relationship, and to show how such information can be incorporated into a direct-reading slide-rule.

STANDARDS AND THE PROBLEM OF PHOTOGRAPHIC EXPOSURE

H. G. MORSE*

ABSTRACT

The latest revision of the American Standard Photographic Exposure Computer PH2.7-1955 is another step in preparation of a group of standards to define the determinants of photographic exposure. This revision simplifies the scene table for negative materials and allows a lower exposure level for nearby and close-up scenes. The nearby classification is now designated "normal" and leads to the same exposure as does the reversal scene index table for bright sun and no shade.

The American Standards Association has just published a new revision of the American Standard Photographic Exposure Computer PH2.7-1955. This is the latest in a co-ordinated group of standards designed to define completely the determinants of photographic exposures.

The problem of exposure is one of the most important and at the same time most difficult in the entire field of photographic standardization. Although at first glance the problem appears to be that of just measuring light on a scene and from this calculating the necessary exposure by simple arithmetic, there is considerably more involved. Common photo-electric exposure meters do not actually measure luminance nor do normal films respond directly to it, as the spectral sensitivity of both these receptors is different from that of the eye as well as from each other. Even after compensation is made for this the quantity measured by meters is illuminance incident on the subject or luminance from the subject area. The quantity of interest to the photographer is the luminance of the deepest shadows he desires to preserve in the final print. Because the possibility of a choice in printing exposure does not exist for reversal materials, exposure determination for these is less concerned with the shadows and more nearly approaches a direct ratio to the over-all illuminance approximately measured by the meters. A printing step allows excellent prints to be made from negatives given more exposure than necessary for the "first excellent print" of Jones.[1] The printing compensation with its allowable safety factor does not exist for a reversal material, which has only one best exposure for a subject.

The American Standards Association made its first attack on the problem in 1942 when, at the request of the U. S. Navy, it prepared the American Emergency Standard Photographic Exposure Computer Z38.2.2. On the basis of work conducted primarily by the Eastman Kodak Company and reported after the war[2] it set up a criterion for outdoor negative film exposure based on a thorough description of weather, shade, direction of illumination and scene type. The sun's elevation was considered in a series of light index tables which covered latitude, season and time of day. The exposure index used in connection with the computer was later defined in another standard. The various factors were combined logarithmically on a dial slide rule type calculator which furnished results in $^1/_3$ stop intervals as a series of f/stop shutter speed combinations.

This computer was published as a leatherette covered booklet small enough to be carried in even a sailor's pocket. It was far more accurate than the commonly used exposure tables which considered only a few of the factors involved and usually expressed their results in full stop intervals. It adopted a safety factor of about 4 times or 2 stops. For the first time a purely descriptive exposure guide rivaled "raw" photographic exposure meter readings in accuracy.

The next step in exposure standardization was made in 1946 when American Standard Z38.2.1 was adopted. This defined the exposure index used in the emergency standard and set up a sensitometric method of exposure index determination using an internationally standardized filtered light source approximating daylight. The fractional gradient method of speed determination followed is valid for continuous tone negative materials printed on multigrade papers. This substance has remained unchanged through the present revision PH2.5-1954.

The first approach to the problem of spectral distribution was also made in 1946 with an American Standard Method for Determining Spectral Sensitivity Indexes and Group Numbers for Photographic Emulsions. By means of calculations from red and yellow filter factors, index numbers were established giving relative sensitivity of a film to each of the red, green, and blue spectral regions. Film with similar sensitivity indexes would show similar changes in effective exposure index for changes in light source color. The current revision of this standard is PH2.6-1954.

In 1949 the Emergency Exposure Computer standard was adapted to civilian use, the illustrations were changed to peacetime subjects, flash was moved to a standard of its own and a scene index table was added to apply to black-and-white and color reversal materials. The current revision takes advantage of the experiences of users of the 1949 standard which indicated that a simplification of some sections was possible.

The guide numbers removed from the computer became American Standard PH2.4 in 1953. As in the original computer, this standard anticipated later work ex-

* Ansco, a Division of General Aniline and Film Corporation, Binghamton 1, New York. Received 2 June, 1955.

tending exposure indexes to light sources other than daylight. In its appendix it established nominal values for exposure factors such as lens transmission, vignetting and the cosine[4] effect.

Another facet of the problem was attacked in 1948 by Z38.2.6 which standardized General Purpose Photographic Exposure Meters. This established constants affecting meter design and calibration as well as giving tolerances for accuracy.

About 2 years ago work was begun to fill up the gaps and complete the project of standardizing exposure determinants for all films, light sources and types of exposures. The first of this group, PH2.3-1953, allowed corrections in exposure indexes to be made for all types of continuous light sources and all spectral sensitivity classes of films. Other standards now in preparation are extending this to momentary and low intensity sources as well. Reversal materials are to be given a special method of exposure index determination.

The current revision of the Exposure Computer PH2.7-1955 is another part of the tightening circle. In addition to furnishing standardized information for use without a light meter its light and scene indexes provide a basis for the conversion of raw exposure meter readings to true exposure values, in accord with the other standards in this group.

This standard, like its predecessor, is a pocket size leatherette booklet which can be carried in the field. It is basically the same in operation as the earlier versions but is set up to give somewhat less exposure for negative films for many photographic situations. The new negative film scene table has one grouping marked "normal" which leads to the same exposure recommended for reversal films in clear sunlight, when both films have the same exposure index.

To operate the computer one first looks up the time of day and month of the year in the proper light index table for his latitude. In the summer months this index is zero for most of the day but the tables give precise corrections for winter and for pictures taken early and late when the sun is near the horizon and light conditions are particularly difficult to judge. This section has not been changed in the revision.

The photographer then turns to the proper scene index table where he first selects the sun conditions, choosing from clear sun, hazy sun, cloudy bright, or cloudy dull and then the proper scene type. The scene index for the combination is read from the table.

There are two tables; one for negative and one for reversal films. The negative table has classifications, distant, nearby (normal) and close-up with the last two subdivided into unshaded, light shade and heavy shade. The table for reversal film is subdivided into front, side and back light with extra columns for light and heavy shade. The booklet contains descriptions and pictures of the various classes of scenes so that the paper choice is made easy.

The major changes in this revision are in the scene index table for black-and-white and color negative films. The earlier versions applied to black-and-white only and had four classes of scenes each separated by a full stop. The new applies to color as well and has only three classes. The distant and semidistant classifications have been combined. The nearby is now designated normal and leads to the same bright sun no shade exposure as is given in the scene index table for reversal films. The close-up now requires only $^2/_3$ stop more exposure than the nearby. The additional exposure for side lighting has been reduced from 1 to $^2/_3$ stop and for back lighting from 2 to 1 stops. In terms of camera settings for a film with an exposure index of 50, clear sun around midday in the summer, these changes mean that for a close-up where the old standard required $^1/_{50}$ second at f/7 for front and f/3.5 for back lighting, the revised version allows f/11 for the front and f/8 for back at the same shutter speed. The revision recognizes the uncertainty in evaluating the cloudy and shade conditions by noting that the heavy shade classification for all sky conditions and the light shade for cloudy sky could be given up to 1 stop additional exposure for greater safety.

The primary reason for this change is that the former versions placed great emphasis on the important small shadow details which are significant in close-up pictures but merge with lighter areas and are diluted by atmosphere haze in more distant scenes. The close-up illustration in the original 1942 Emergency Standard was an airplane cockpit with detail desired even in the darkest recesses of the instrument panel. The present illustration for this class, two children on a doorstep, has more open lighting in the important small shadows. Experience with the standard in use showed that lower exposure levels for close-up and nearby scenes were still adequate to give a safety factor of 2.5 times for these situations.

Only minor changes were made in the scene index table for black-and-white and color reversal films. The same general change in correction for side and back lighting as given for negative films was made here. There is a $^2/_3$ stop increase for side lighting and for back lighting for lighting effect, and a full stop for back lighting when shadow detail is wanted.

The photographer adds the light index and scene index he has obtained from the tables. He then selects the exposure index for the film he is using on the inner movable dial of the circular slide rule calculator which is a part of the standard computer and matches it against the sum of the indexes on the top stationary scale. The available combinations of f/numbers and shutter speeds which he can use are read directly on the lower pair of scales. For i.e.: Washington, D. C., 8 A.M., October, hazy sky, semidistant side-lit subject, negative film, Exposure Index 50. Light Index is 3. Scene Index is 3 plus 2 (side lighting). Light Index plus Scene Index is 8. Set 50 on dial at 8. Correct exposures are: $^1/_{50}$ at f/8, $^1/_{100}$ at f/5.6, etc.

The logarithmic index numbers were selected so that each unit represents $^1/_3$ stop or an increment of $\sqrt[3]{2}$. Other factors were arranged on the calculator dial so that the same spacing represents a $^1/_3$ stop exposure change in all cases. This allows a simple 1 setting solution of a problem which would normally be solved by the following equation:

$$\text{Log}\, T - 2\,\text{Log}\, f + 2.6 = \frac{\text{Light Index} + \text{Scene Index}}{10} - \text{log film Exposure Index}$$

(Where T is exposure time in seconds, f is f/number of lens opening.)

An appendix published with the computer includes a table of exposure indexes for most commonly used films. Manufacturers' ratings are included for both black-and-white and color in negative and reversal classes.

This revision was prepared by subcommittee PH2-10 of ASA Sectional Committee on Photographic Sensitometry PH2. Members are:

M. G. Anderson, Chairman, ... Ansco;
C. N. Nelson, ... Eastman Kodak;
A. G. Stimson, ... General Electric.

Copies of the American Standard Photographic Exposure Computer PH2.7-1955 may be obtained directly from the American Standards Association, Incorporated 70 East 45th Street, New York 17, New York, for $1.50 postpaid

REFERENCES

1 Jones, L. A., "The Evaluation of Negative Film Speeds in Terms of Print Quality." Franklin Inst., Vol. 227, pp. 297, 497 (1939).

2 Jones, L. A. and Condit, H. R., "Sunlight and Skylight as Determinants of Photographic Exposure." J. Opt. Soc. Amer. Vol. 38, pp. 123-178 (1948); Vol. 39, pp. 94-135 (1949).

BOOK REVIEW

PROGRESS IN PHOTOGRAPHY, 1951-1954; Volume Two of an International Record. D. A. Spencer, Editor-in-Chief. Published by Focal Press, Limited, London, 336 pages, illustrated. Available in the United States from American Photographic Book Pub. Co., Inc., New York 23, N. Y., $10.00.

The aim of "Progress in Photography," as explained by Editor Spencer in the Introduction to Volume 2, is "to bridge the gap between the average text book and the specialist literature on photographic theory and applications." This useful work does more than provide a reference source for the benefit of the great body of photographic readers who are not either innocent, like the student or the neophyte in photography, on one hand, or intensely interested in some single field of photographic specialization. The book sums up in readable form a variety of sound information about practical and theoretical accomplishments of photography in many countries. It presents that information backed with the reliability and the authority of some of the outstanding names in photographic technology in the western world. An international Board of Editors has assisted Dr. Spencer in reviewing the contributions.

The present volume includes a few fields of photographic applications during the period 1940-1950 that had been neglected in Volume 1. In the main it deals with timely subjects but occasionally touches on earlier aspects of a particular subject in order to provide a complete picture.

The completeness of the subject matter may be guessed from the titles of the ten sections into which the contents of the volume have been grouped: (1) Photographic equipment, (2) Photographic theory and (sensitized) materials, (3) Color photography, (4) Processing, (5) Motion pictures, (6) Special techniques—High-speed, photomicrography, stereo, (7) Special applications—forensic, astronomical, medical, industrial, etc., (8) Radiography and diffraction, (9) Commerce and industry, (10) Organizations.

Twenty-six of the contributions have been written by authors resident in the United States and twenty-eight by authors in Great Britain. Germany is represented by seven contributions and France and Italy by one each. The photographic accomplishments of Japan, Switzerland, and Belgium lack the complete review that might be expected if writers more intimately concerned with photographic activities within those countries had described them.

Photographic manufacture behind the "iron curtain," with respect to cameras and apparatus, has been covered in detail by Dr. Leo Busch of Berlin (Western Zone), based on the catalog listings of the Autumn 1952 Leipzig Fair. Cameras and apparatus currently being advertised in the United States as "imported" are appraised here as products of the D.D.R. (*Deutsche Demokratische Republik*).

The Sections dealing with photographic theory are capably documented. One could wish, however, that the editors had brought a little more uniformity into the listing of bibliographical references. Apparently these were allowed to appear in print in the way the authors prepared them. The several authors, however, followed different styles in compiling bibliographies.

The lack of editorial revision to standardize the literature references has been more than compensated by an excess of editorial zeal in revising the contributions of American authors to provide British spelling of such words as colour, defence, programme, connexion. This no doubt has been done to provide uniformity with the papers by British authors and marks the work as something edited primarily for the British literary market.

Uniformity has been overlooked in the editing, however, in other instances, for example: The correct symbols ASA, ISO and ISA are shown on some pages but incorrect A.S.A., I.S.O., and I.S.A., with periods, may be found on other pages, or even in some cases on the same pages. In general the typography and presswork are excellent and the proof reading is satisfactory though Mr. Raymond Davis at the National Bureau of Standards will doubtless be surprised at the reference on page 90 to "Davies-Gibson" filters.

Writers on photographic subjects, executives in photographic organizations, individuals who want to know the right answers, people who are expected to know what is going on in photography today, all will find this book a valuable desk companion. The aim of the publishers, to provide a handy reference volume that will serve in years to come as a fundamental source of reference, seems to have been realized.